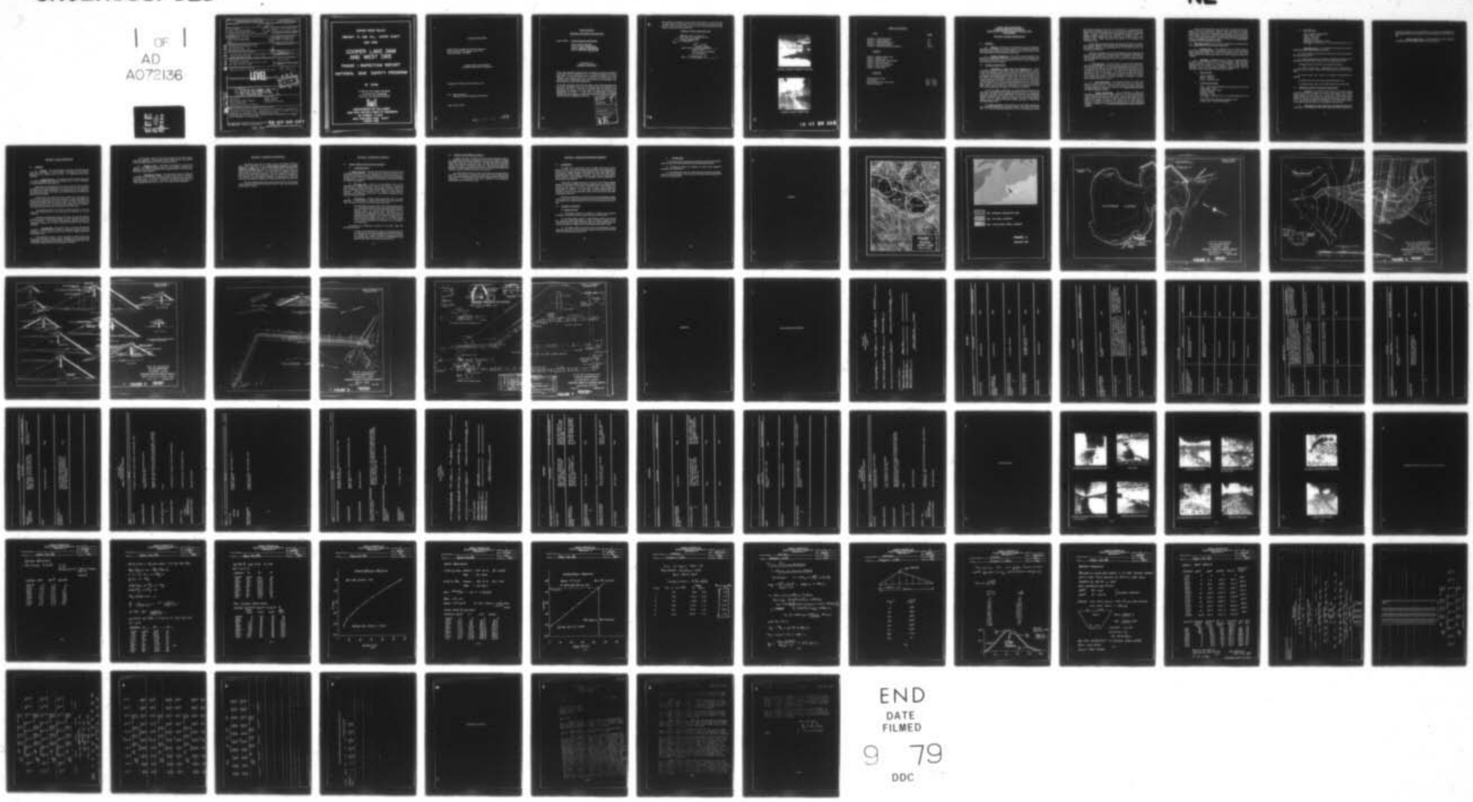
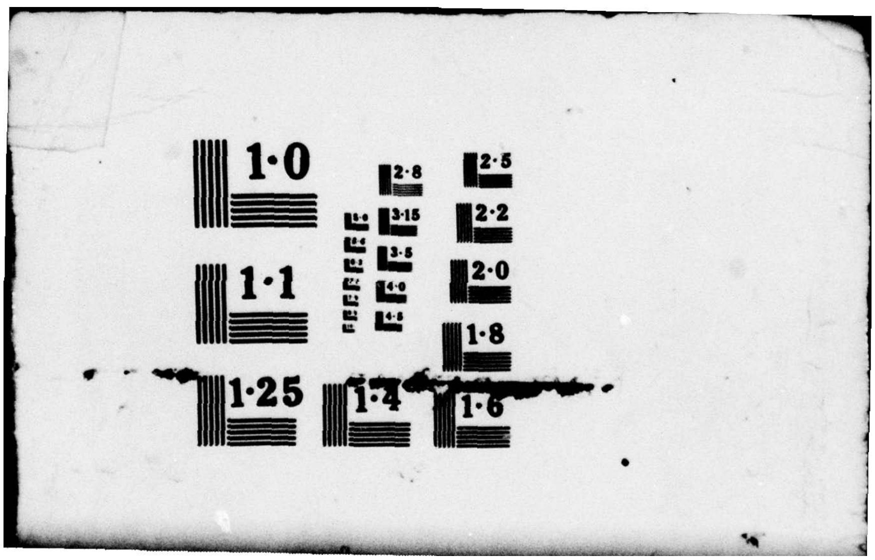
AD-A072 136 NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/2
NATIONAL DAM SAFETY PROGRAM. COOPER LAKE DAM AND WEST DIKE (NYO--ETC(U)
SEP 78 J J WILLIAMS DACW51-78-C-0035

UNCLASSIFIED NL

1 OF 1
AD
A072136



END
DATE
FILMED
9 79
DDC


1·0
2·8
2·5
3·15
2·2
3·5
1·1
2·0
4·0
4·5
1·8
1·25
1·4
1·6

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report Cooper Lake Dam and West Dike Hudson River Basin, Ulster County, New York Inventory No. N.Y. 81 (5) B.S		5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John J. Williams ~~P.E.~~ (10)		8. CONTRACT OR GRANT NUMBER(s) (15) DACW-51-78-C-0035
9. PERFORMING ORGANIZATION NAME AND ADDRESS O'Brien and Gere Engineers, Inc. 1301 Buckley Road Syracuse, New York 13221		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS New York State Department of Environmental Conservation/ 50 Wolf Road Albany, New York 12233 393 970		(11) 12. REPORT DATE 21 September 1978
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Department of the Army 26 Federal Plaza/ New York District, CofE New York, New York 10007		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; Distribution unlimited. (12) 76p.

LEVEL

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DDC RECEIVED JUL 31 1979 C

18. SUPPLEMENTARY NOTES

(6) **National Dam Safety Program, Cooper Lake Dam and West Dike (NY 00081), Hudson River Basin, Ulster County, New York. Phase I Inspection Report.**

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety
National Dam Safety Program
Visual Inspection
Hydrology, Structural Stability
Cooper Lake Dam
Ulster County
Tributary to Saw Kill

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.
Cooper Lake Dam was found to safe, although further investigation of seepage in the embankment was recommended.

79 07 30 033

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

393 970

AD A072136

DDC FILE COPY

HUDSON RIVER VALLEY

TRIBUTARY TO SAW KILL, ULSTER COUNTY

NEW YORK

COOPER LAKE DAM
AND WEST DIKE

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NY 00081

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

CONTRACT NO. DACW 51-78-C-0035

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007
AUGUST 1978

HUDSON RIVER BASIN

Name of Dam: Cooper Lake Dam and West Dike
County and State: Ulster County, New York
Inventory Number: NY 00081

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by: O'Brien and Gere Engineers, Inc.

For: New York State
Department of Environmental Conservation

Date: July 27, 1978

79 07 30 033

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Cooper Lake Dam and West Dike

State Located: New York
County Located: Ulster County
Stream: Tributary to the Saw Kill
Date Of Inspection: June 27, 1978

ASSESSMENT OF GENERAL CONDITIONS

During the inspection, isolated areas of seepage and water discoloration were evident at the downstream toe of the earth embankment of Cooper Lake Dam. At the West Dike, which is located at another area of the Reservoir near Cooper Lake Dam, a large area of ponded water with isolated areas of discoloration was evident along most of the length of the downstream toe of the earth embankment.

In the case of Cooper Lake Dam, the source of the isolated seepage areas and water discoloration may be from springs which are reported to be common in the area. In the case of the West Dike, the ponding at the downstream toe appears to be the result of beaver dams located just downstream of the site. In either case, the possibilities of excessive seepage and fines migration through the embankments should not be ruled out until further investigations are made.

Accession For
NTIS GRA&I
DDC TAB
Unannounced
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or special
A | 23

The spillway is adequate to pass flood flows equal to or less than the Probable Maximum Flood with .6 feet of freeboard still available between the PMF water surface elevation and the top of the embankment of both Cooper Lake Dam and the West Dike.

O'BRIEN & GERE ENGINEERS, INC.

John J. Williams

John J. Williams, P.E.
Vice President

Approved by: Clark H. Benn

Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 21 September 78

OVERALL VIEW OF COOPER LAKE DAM

OVERALL VIEW OF WEST DIKE

79 07 30 033

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM COOPER LAKE DAM AND WEST DIKE
ID # NY 00081

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - This report is authorized by the Dam Inspection Act, Public Law 92-367 and has been prepared in accordance with contract #1467.021 between O'Brien and Gere Engineers, Inc., and the State of New York, Department of Environmental Conservation.

b. Purpose of Inspection - The purpose of this inspection is to evaluate the structural, hydraulic and hydrologic conditions of Cooper Lake Dam and the West Dike and to determine if the dam or dike constitutes a hazard to human life or property.

1.2 PROJECT DESCRIPTION

a. Description of Dam, Dike and Appurtenances - (From information provided by the State of New York, Department of Environmental Conservation) Cooper Lake is located in Ulster County, New York, in the town of Woodstock, approximately three (3) miles northwest of the community of Bearsville (population 300 to 500). The lake is formed by two (2) rolled earth embankments: Cooper Lake Dam and the West Dike. Cooper Lake Dam is situated on the northeastern corner of the reservoir and the West Dike forms the northwestern border of the lake. The surface area of Cooper Lake accounts for approximately 35% of the total drainage basin. Water from the reservoir is discharged into a tributary of the Saw Kill which proceeds south through the community of Bearsville.

In the year 1800, a single dam was constructed at the site of the main dam. The original water surface elevation was 1092.3. Between the years 1899 and 1927, various modifications and additions were undertaken including construction of the West Dike. In later years (approximately 1959), a 10" high timber stoplog was added to the top of the concrete spillway crest to increase the water surface elevation to 1103.83 (see photographs,page #A2).

1) Cooper Lake Dam - The main dam is a rolled earth embankment with rock-lined upstream and downstream slopes. The grades of the slopes are 1 on 2 for the upstream face and 1 on 1½ for the downstream face.

The structural height of the dam is forty (40) feet. The present earth embankment was constructed over top of the original dam (built in the year 1800). The top of the original dam was excavated in order to expose the original corewall, which was then extended to elevation 1104. An additional earth embankment was placed to the present top of dam elevation 1180. Riprap protection was added to the upstream and downstream faces.

At the right (looking downstream) abutment of the dam is a concrete lined overflow spillway with a concrete weir and timber stoplog. Flow over the spillway passes by the downstream toe of the dam and into the tributary of the Saw Kill.

The dam is equipped with two (2) 20" pipes for water supply to the city of Kingston, New York. Discharge through these pipes is controlled by manually operated intake and outlet valves. According to the operator, who accompanied the inspection team, all valves are exercised at least twice a year.

2) The West Dike - The West Dike is a rolled earth embankment with a maximum height of 18 feet and an approximate length of 1,515 feet. The upstream face slope is 1 on 2½ and the downstream face slope is 1 on 2. The upstream face is lined with 14" thick rock and the downstream face is covered with 6" rock and gravel. Top width is ten (10) feet and top elevation is 1,108. At the northern end of the dike, 2 pipes, 24" and 12", enter Cooper Lake from the Mink Hollow System. Discharge into Cooper Lake through these pipes is manually controlled to maintain a constant water surface elevation in the lake.

b. Size Classification - The structural height of Cooper Lake Dam is forty (40) feet and that of the West Dike is 18 feet. Maximum storage is 3,683 acre-feet. Therefore, both the dam and West Dike are in the intermediate size category as defined by the Recommended Guidelines For Safety Inspection of Dams.

c. Hazard Classification - The communities of Shady and Bearsville are downstream of Cooper Lake Dam. The combined population of both communities is estimated to be 500. Cooper Lake is used for water supply for the city of Kingston. A failure of the dam would result in loss of human life, damage to property and partial loss of water supply to Kingston. Therefore, the main dam is considered to be in the high hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

Failure of the West Dike would also result in partial loss of water supply to the city of Kingston. However, only a few homes are located downstream of the dike and topography is such that failure of the dike would result in sheet flow. Damage to personal property would result but loss of human life is not probable. Therefore, the West Dike is considered to be in the significant hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.3 PERTINENT DATA (From information provided by the State of New York, Department of Environmental Conservation)

a. Drainage Area - The drainage area of Cooper Lake is approximately 0.7 square miles as determined from the U.S. Geological Survey Quadrangle Sheets (7.5 minute) for Bearsville, New York. The water surface of the lake is about 35% of the total drainage area (elevation 1103.83)

b. Discharges - Discharges from the reservoir are accomplished by means of two 20" pipes and an overflow spillway. With the water surface elevation at the top of the dam (elevation 1108), maximum discharge over the spillway is approximately 1,012 cfs and maximum discharge through the two pipes combined is approximately 148 cfs. Drawdown is also accomplished through these two pipes.

c. Reservoir Data

Length - 3,000 feet
Width - 3,500 feet
Volume - 3,683 acre-feet

d. Cooper Lake Dam Data

Type - rolled earth embankment with concrete cut-off wall
Top Elevation - 1,108
Tailwater Elevation - 1,065
Length - 460 feet
Top Width - 12 feet
Side Slopes - upstream face - 1 on 2; downstream face -1 on 1.5
Cutoff - concrete cutoff wall to elevation 1,104
Outlet Works - Two (2) 20" steel pipes

e. West Dike Data

Type - rolled earth embankment
Top Elevation - 1,108
Length - 1,515 feet
Top Width - 10 feet
Maximum Bottom Width - 91 feet
Side Slopes - upstream face - 1 on 2.5; downstream face -1 on 2

f. Engineering Data - The information provided for review of Cooper Lake Dam and the West Dike included:

1) A set of seven (7) drawings for Cooper Lake Dam and the West Dike dated February,1927.

2) Letter from Sanborn and Bogert Consulting Engineers to the Department of Public Works, Albany, New York dated April 14, 1927.

3) Department of Conservation, Dam Inspection Report.

4) State of New York - Applications for the Construction on Reconstruction of a Dam at Cooper Lake dated December, 1923 and March, 1927.

5) State of New York - Report of a Structure Impounding Water, undated.

6) State of New York Dam Report dated September, 1914.

7) Geologic Map of New York, Hudson-Mohawk Sheet dated 1961.

1.4 OPERATING AND MAINTENANCE PROCEDURES

a. Operation - The reservoir serves as part of the water supply system for the city of Kingston, New York. Water passes from the Mink Hollow System via a 24" pipe and a 12" pipe into Cooper Lake. Water passes through two (2) 20" pipes, from Cooper Lake to the city of Kingston. Valves for all lines are manually operated and exercised at least twice a year. The operator regulates the discharge from the Mink Hollow System to maintain a constant water surface elevation in the reservoir.

b. Maintenance of Dam, Reservoir, and Operating Facilities - Maintenance is performed on the main dam, West Dike, reservoir and

operating facilities on an "as needed basis". An operator is employed on a "year around" basis for the Cooper Lake System and is on call 24 hours per day.

c. Flood Warning System - No flood warning system has been established other than verbal warning from the operator.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of Cooper Lake Dam and the West Dike took place on June 27, 1978. The reservoir water surface elevation was at spillway crest (1103.83). No underwater areas were inspected.

b. Cooper Lake Dam - The upstream face of the dam is covered with uniformly graded rocks ranging in diameter from 2" to 18". No erosion or surface depressions were apparent.

Inspection of the downstream face, also covered with rock, indicated no apparent structural misalignment. At one area near the left abutment, the slope of the natural groundline at the downstream toe is steeper than the embankment slope. No erosion was evident and surface maintenance appeared to be adequate.

Flowing water and discoloration were observed at one location at the toe of the dam with an estimated discharge of 1 gpm. Discussion with the operator revealed that water from this point was tested for content and found to be different than the reservoir water. The owner concluded that this discharge was from a spring rather than seepage from the reservoir, since small springs of this type are characteristic of the area.

The gatehouse interior and exterior, visible portions of the inlet tower, and visible portions of the outlet pipes all appeared to be in good condition.

The timber stoplog installed above the crest of the concrete spillway is deteriorating and considerable seepage is evident between the concrete and the timber. The concrete lined spillway approach channel and downstream channel are in good condition with only minor concrete cracking.

c. The West Dike - The upstream face of the West Dike and the surface of the top of the dike exhibit no significant signs of structural instability. A few trees and a thick cover of ferns or aquatic plants line the upstream face.

The downstream face of most of the dike is covered with trees, heavy brush and ferns or aquatic plants. Standing water is present at the downstream toe along most of the length of the dike and some of this water is discolored. Beaver dams exist downstream of the dike.

The concrete exterior of the inlet manhole for the Mink Hollow Lines was inspected. Considerable concrete deterioration has occurred with the headwall broken into two (2) separate sections.

d. Reservoir Area - The banks of the reservoir are heavily wooded. The slopes are fairly steep and well defined. Sediment was apparent in the spillway approach channel approximately 5 to 6 feet below the water surface elevation.

e. Downstream Channel - The downstream channel is adjacent to the toe of the main dam. Debris is present in the form of tree trunks and fallen trees. A small foot bridge is also present allowing access to fields downstream of the dam. The debris is sufficiently concentrated to cause considerable obstruction to flow in the event of high discharges.

SECTION 3 - HYDROLOGY/HYDRAULICS

The design flood used for Cooper Lake is the Probable Maximum Flood (PMF) according to the Recommended Guidelines for Safety Inspection of Dams. The reservoir water surface area at spillway crest accounts for approximately 35% of the drainage basin and the slopes are fairly steep and well defined. U.S. Army Corps of Engineers computer program HEC-1 was used to determine the PMF. Peak inflow and outflow rates for the PMF were calculated as 3,434 cfs and 905 cfs respectively. The maximum non-overtopping discharge is approximately 1,108 cfs. Therefore, the spillway is adequate for discharges associated with the PMF.

The time required to draw the reservoir down from the normal water surface elevation of 1103.83 to elevation 1068 is 57 days, (see computation sheets #A-27 & #A28).

SECTION 4 - STRUCTURAL STABILITY

4.1 VISUAL OBSERVATION AND DATA REVIEW

a. Visual Observation

1) Cooper Lake Dam - Cooper Lake Dam shows no significant signs of embankment instability. The upstream and downstream faces of the embankments indicate no apparent misalignment. Wet spots downstream of the dam may be attributed to springs characteristic of this area or seepage through the dam. Conclusive analysis of this condition is beyond the scope of a Phase I investigation.

2) The West Dike - Most of the downstream face of the embankment is wooded indicating extensive root systems. In addition, standing water is present along most of the length of the West Dike at its toe. As discussed in Section 2 above, Beaver Dams may have caused this condition. Although the elevation of the roadway is fairly uniform, numerous small depressions were noted. No abnormal depressions were noted on the upstream face.

b. Data Review - Original design calculations were not made available. A brief report by Sanborn and Bogert Consulting Engineers, 1927, revealed the following concerning Cooper Lake Dam:

> "It is proposed to raise the water of the Lake a little less than 11'. The proposed design of the dam contemplates raising the corewall which is to be carried across the existing masonry spillway section and placing earth embankment on the existing slopes and parallel with them. The earth slopes are thoroughly well established. The downstream slope stands at present somewhat steeper than 1 on $1\frac{1}{2}$. Soundings on the water side show the slope to be about 1 on $1\frac{1}{2}$. The material of the existing embankment of this dam is well compacted and impervious."

Concerning the embankment material at the West Dike, the following was noted:

> "in view of the slight depth of water, we understood that the corewall could be omitted, particularly since the material for this embankment is ideal, consisting of sandy loam carrying just enough clay material so that the embankment packs perfectly and makes a thoroughly impervious dam."

4.2 GEOLOGY AND SEISMIC STABILITY

Coopers Lake Dam is located within the Catskill Mountain area of the Appalachian Uplands physiographic province in moderate to rugged topography formed by stream dissecting the underlying, nearly horizontal shales and sandstones of Devonian age. The dam rests on till and drift deposits, the result of Pleistocene glaciation. These materials have been described in design documents as hard clay and hardpan with cobbles and boulders. Depth to bedrock at the dam is not known.

No fault zones are known to exist in the vicinity of the main dam or west lake. The structure is located in Seismic Zone 1 of the Seismic Zone Map of Contiguous States, and it appears that static stability conditions are satisfactory. No earthquakes have been recorded of any significant magnitude within 50 miles of the dam.

SECTION 5 - ASSESSMENT/REMEDIAL MEASURES

5.1 ASSESSMENT

The slope of the downstream face of Cooper Lake Dam is fairly steep (1 on $1\frac{1}{2}$). At one area, the natural groundline at the downstream toe falls off more steeply than does the downstream slope of the embankment. Nevertheless, neither Cooper Lake Dam nor the West Dike shows significant signs of embankment instability. Rock cover on both embankments appears in good condition: No significant erosion, settlement or deterioration was observed.

In the case of Cooper Lake Dam, the source of the isolated seepage areas and water discoloration may be from springs which are reported to be common in the area. In the case of the West Dike, the ponding at the downstream toe appears to be the result of beaver dams located just downstream of the site. In either case, excessive seepage and fines migration through the embankments should not be ruled out until further investigations are made.

The concrete spillway and downstream channel are adequate to pass a flood equal to or less than the Probable Maximum Flood with two (2) feet of freeboard still available between the water surface elevation and top of dam.

5.2 REMEDIAL MEASURES

a) Cooper Lake Dam

1) Piezometers should be installed to monitor pore pressures throughout the embankments of Cooper Lake Dam and West Dike.

2) A boring program should be implemented in order to determine the necessary design parameters to make a stability analysis of the downstream slope of Cooper Lake Dam especially at the section where the natural groundline is steeper than the downstream embankment slope.

3) All debris should be removed from the downstream channel, especially near the toe of the dam where fallen trees and tree trunks could cause considerable obstruction to flow.

b. <u>The West Dike</u>

1) The beaver dams, located just downstream, should be removed in order to allow for further examination of the downstream toe area.

2) Piezometers should be installed to monitor pore pressures throughout the embankment.

3) The downstream face of the dike should be cleared of the heavy growth of trees and brush. The few trees on the upstream face should also be cut near the groundline.

FIGURES

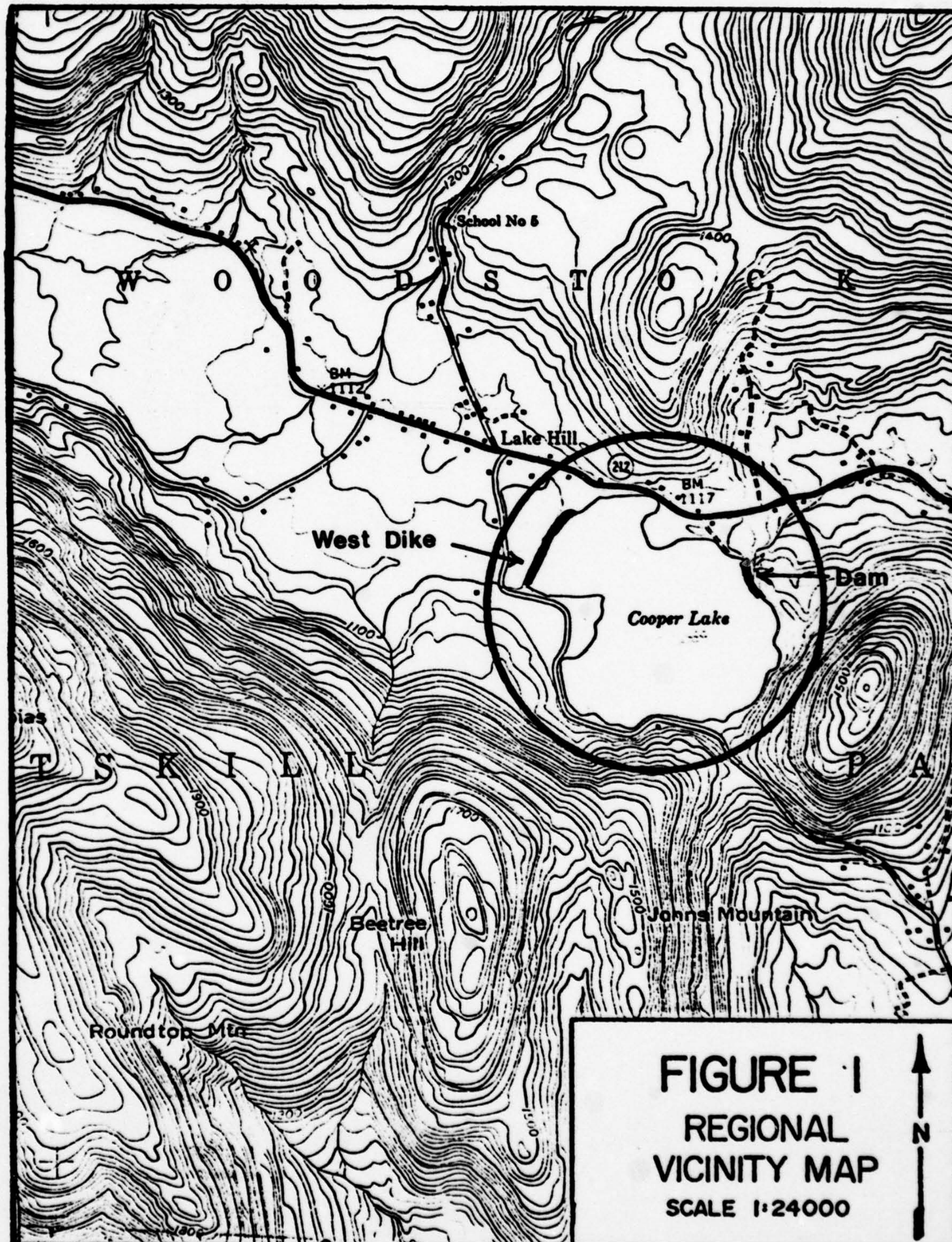
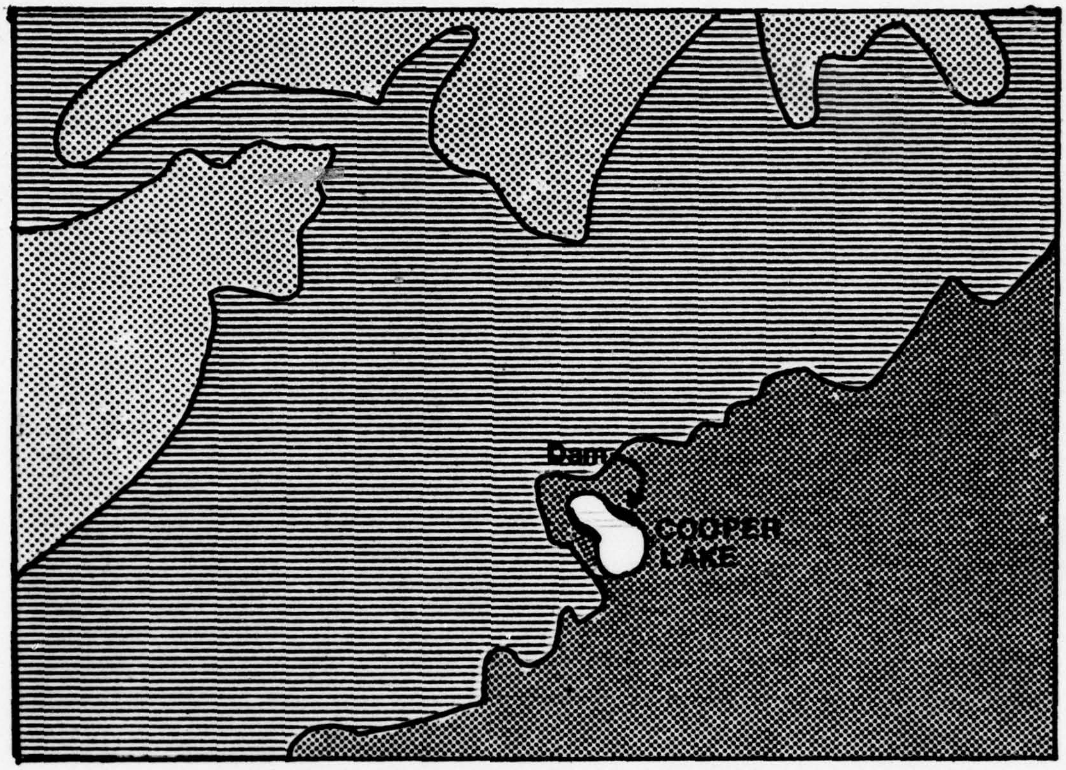


FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24000



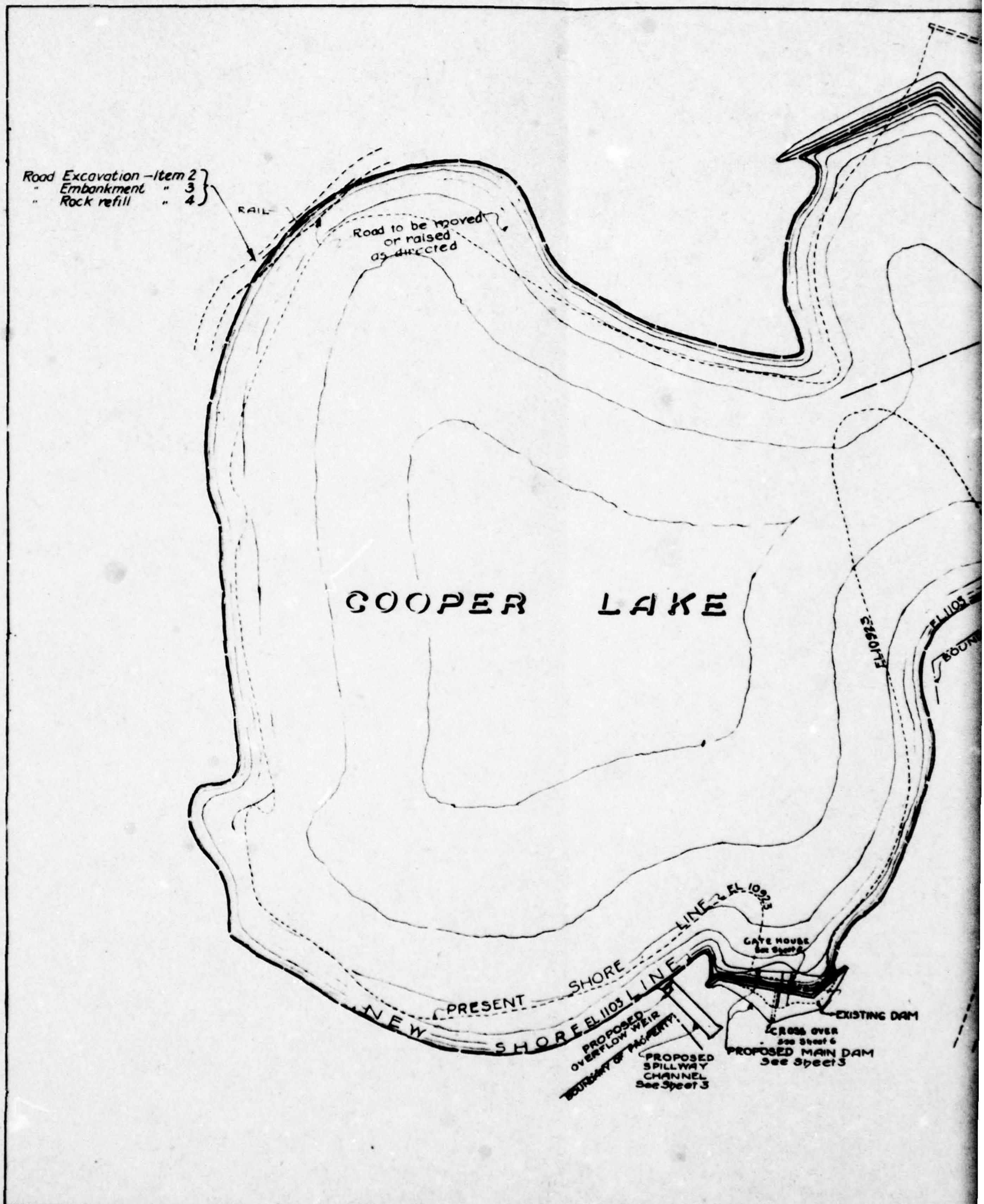
Dss - sandstone, conglomerate, shale

Dgk - red shale, sandstone

Dha - red and green shales, sandstone

FIGURE 2

GEOLOGIC MAP



Road Excavation - Item 2
" Embankment " 3
" Rock refill " 4
RAIL
Road to be moved or raised as directed
COOPER LAKE
EL 1092.3
EL 1105
PRESENT SHORE LINE
NEW SHORE LINE EL 1103
GATE HOUSE
EXISTING DAM
CROSS OVER
PROPOSED MAIN DAM See Sheet 3
PROPOSED OVERFLOW WEIR
BOUNDARY OF PROPERTY
PROPOSED SPILLWAY CHANNEL See Sheet 3

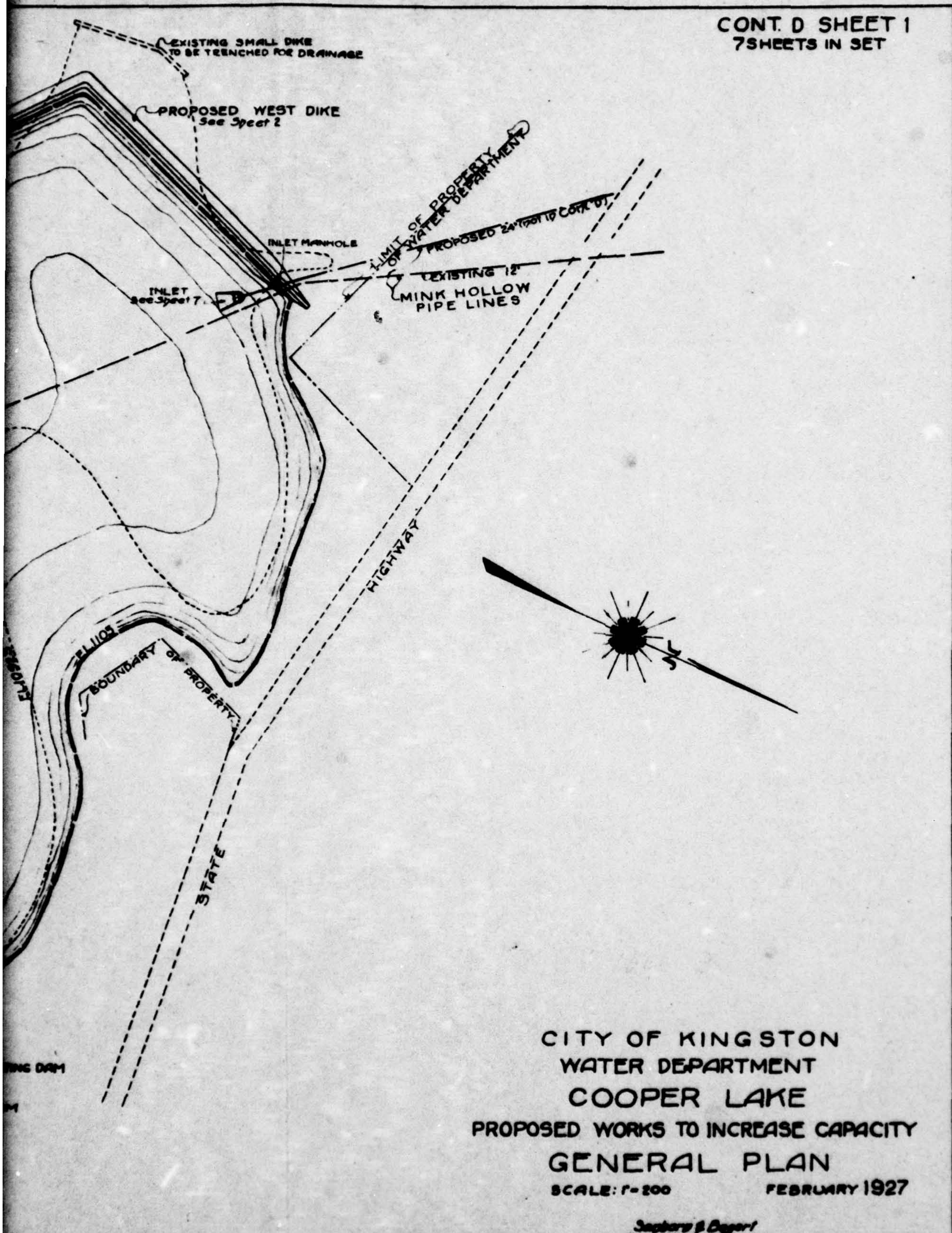
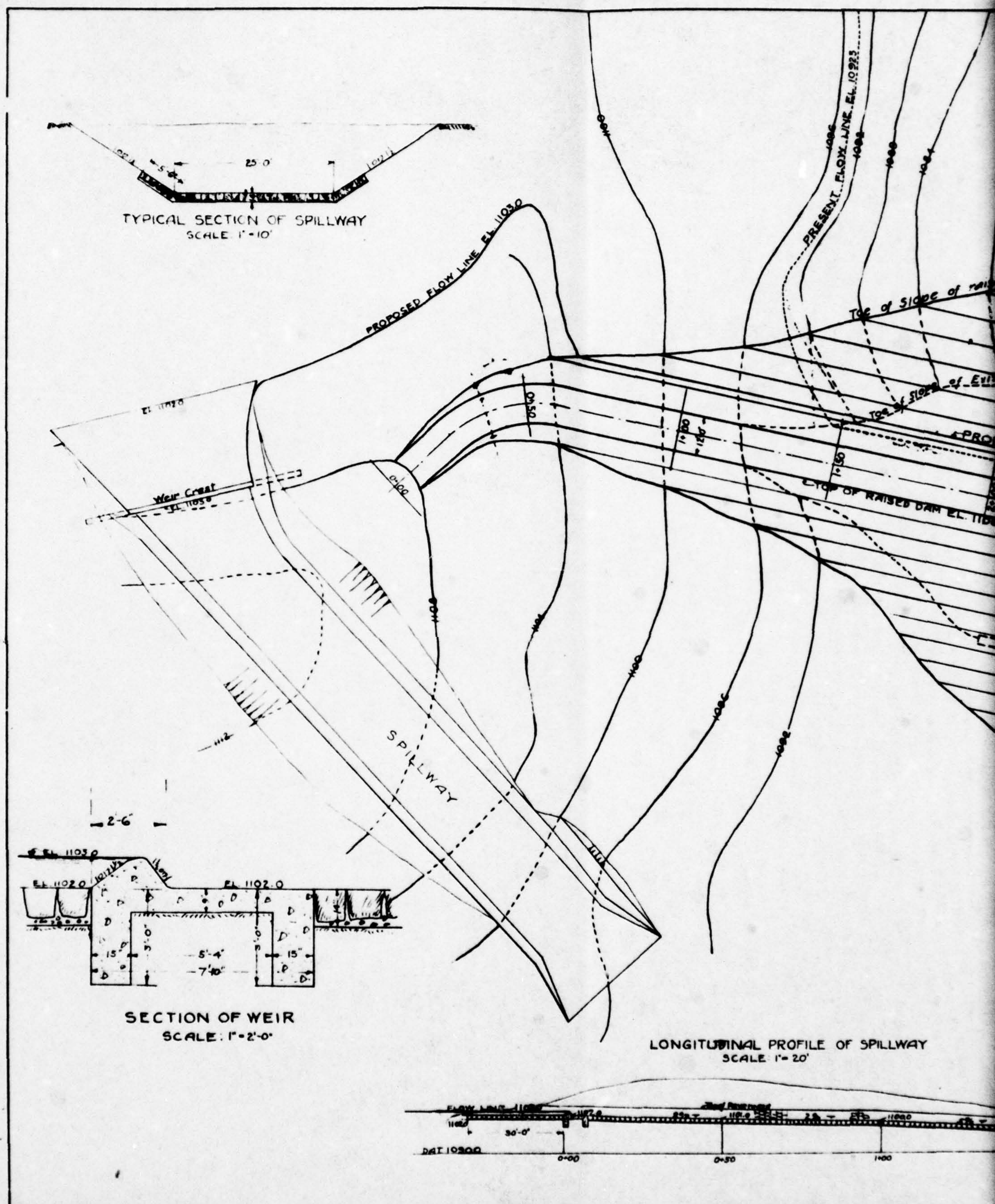
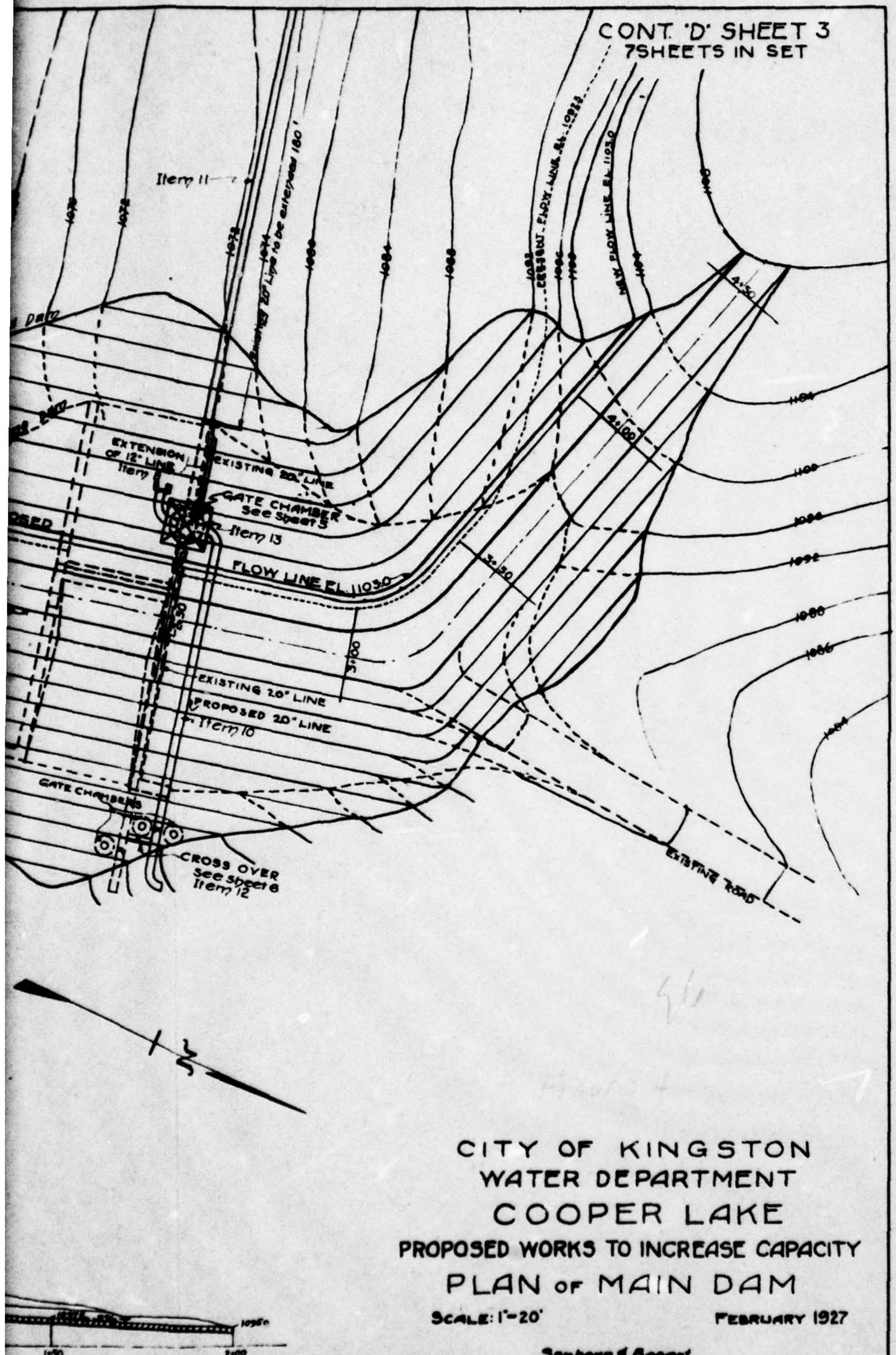

CONT. D SHEET 1
7 SHEETS IN SET
EXISTING SMALL DIKE TO BE TRENCHED FOR DRAINAGE
PROPOSED WEST DIKE
See Sheet 2
LIMIT OF PROPERTY OF WATER DEPARTMENT
INLET MANHOLE
INLET
See Sheet 7
EXISTING 12"
MINK HOLLOW PIPE LINES
HIGHWAY
STATE
BOUNDARY OF PROPERTY
EL.1105
CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
GENERAL PLAN
SCALE: 1"=200
FEBRUARY 1927
Consulting Engineers
New York City

FIGURE 3

2

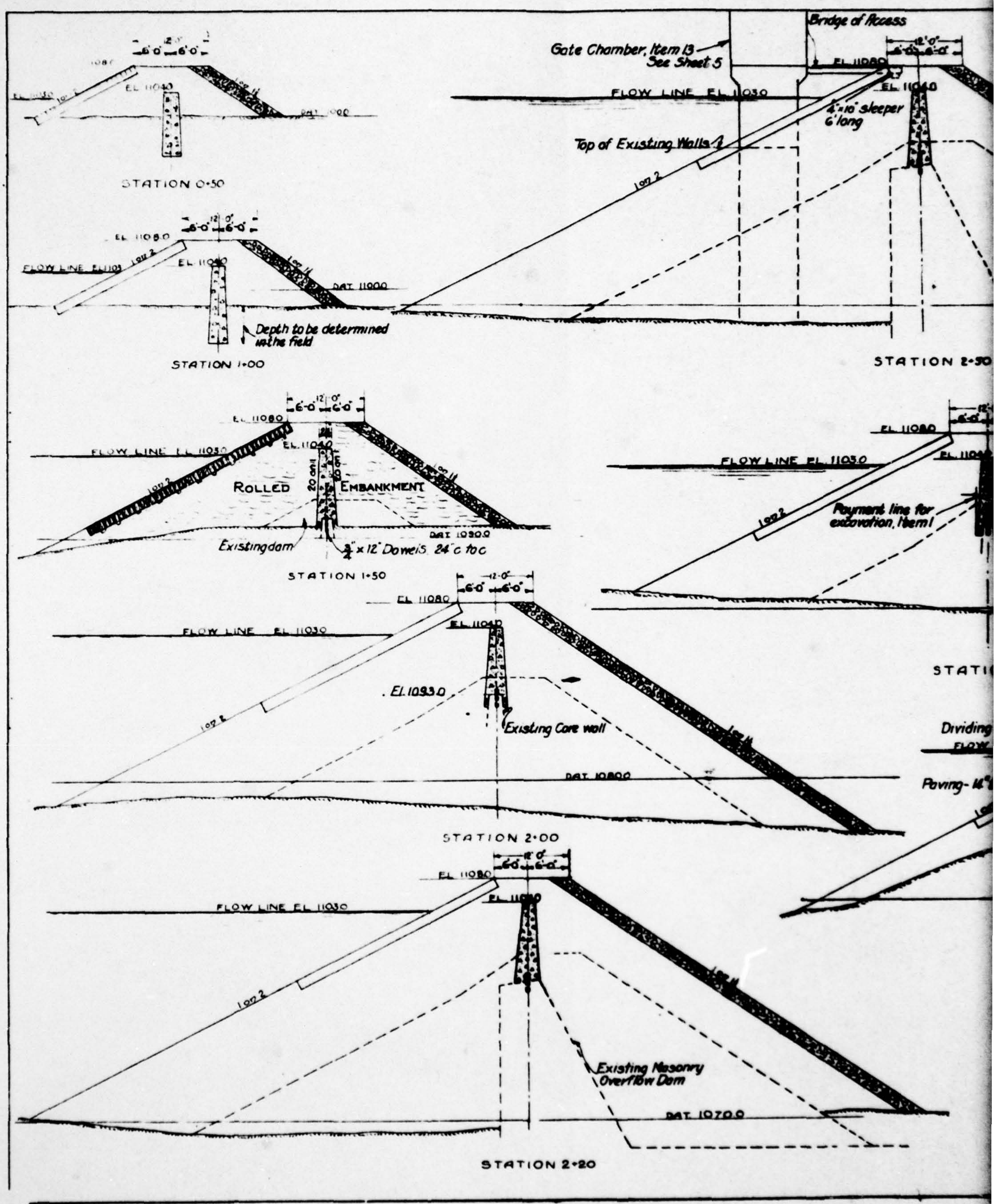


TYPICAL SECTION OF SPILLWAY
SCALE: 1"=10'
25'-0"
PROPOSED FLOW LINE EL. 1103.0
PRESENT FLOW LINE EL. 1092.3
Toe of Slope of Raised
Toe of Slope of Exis
PROP
TOP OF RAISED DAM EL. 110
Weir Crest
EL. 1103.0
EL. 1112.0
SPILLWAY
2'-6"
EL. 1103.0
EL. 1102.0
EL. 1102.0
15"
5'-4"
15"
7'-10"
SECTION OF WEIR
SCALE: 1"=2'-0"
LONGITUDINAL PROFILE OF SPILLWAY
SCALE: 1"=20'
30'-0"
DAT 1090.0
0+00
0+50
1+00


CONT. 'D' SHEET 3
7SHEETS IN SET
Item 11
EXISTING FLOW LINE EL. 1097.3
NEW FLOW LINE EL. 1103.0
EXTENSION OF 12" LINE
EXISTING 20" LINE
GATE CHAMBER See Sheet 5
Item 13
FLOW LINE EL. 1103.0
EXISTING 20" LINE
PROPOSED 20" LINE
Item 10
GATE CHAMBERS
CROSS OVER See Sheet 8 Item 12
EXISTING ROAD
CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
PLAN OF MAIN DAM
SCALE: 1"-20'
FEBRUARY 1927
Sanborn & Bogert
Consulting Engineers
New York City

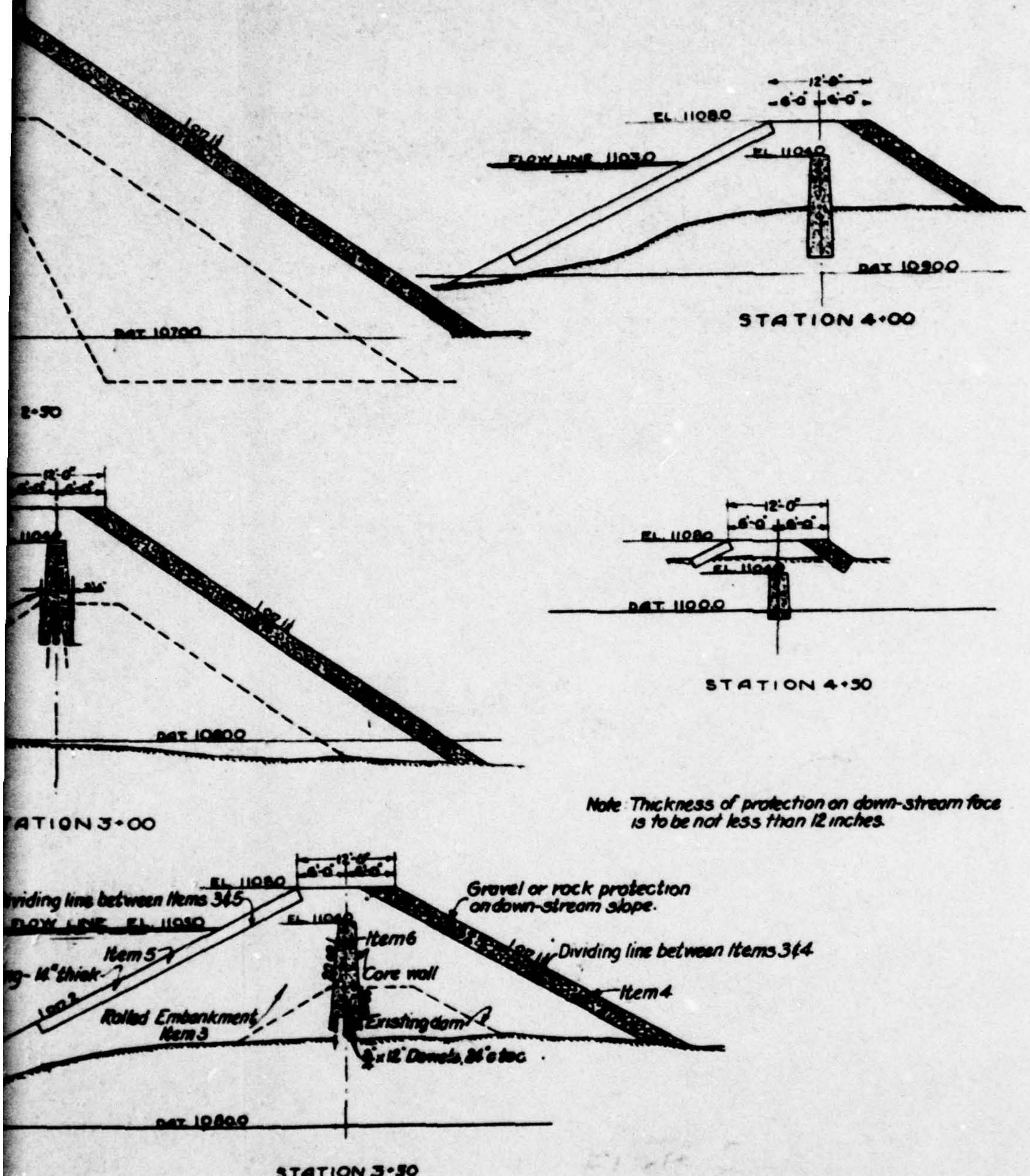
2

FIGURE 4



Bridge of Access
Gate Chamber, Item 13 See Sheet 5
EL 1108.0
FLOW LINE EL 1103.0
EL 1104.0
4"x10" sleeper 6' long
Top of Existing Walls
1 on 2
STATION 2+50
STATION 0+50
EL 1108.0
FLOW LINE EL 1103
EL 1104.0
DAT 1100.0
Depth to be determined in the field
STATION 1+00
EL 1108.0
FLOW LINE EL 1103.0
EL 1104.0
ROLLED EMBANKMENT
Existing dam
3/4" x 12" Dowels 24" c to c
DAT 1090.0
STATION 1+50
EL 1108.0
FLOW LINE EL 1105.0
Payment line for excavation, Item 1
EL 1108.0
FLOW LINE EL 1103.0
EL 1104.0
EL 1093.0
Existing Core wall
DAT 1080.0
STATION 2+00
EL 1108.0
FLOW LINE EL 1103.0
EL 1108.0
Existing Masonry Overflow Dam
DAT 1070.0
STATION 2+20

CONT. D SHEET 4
7 SHEETS IN SET

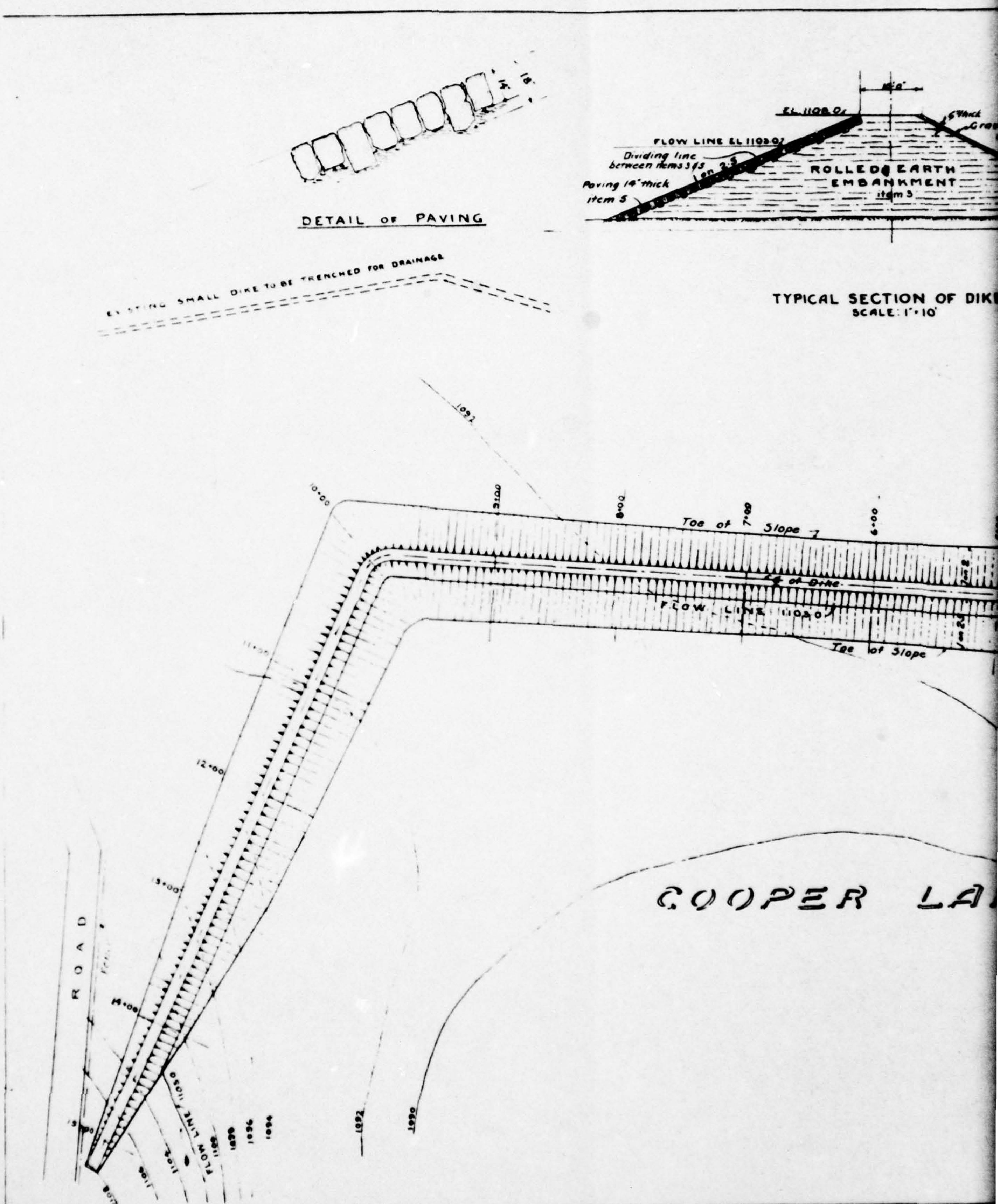


CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
SECTIONS OF MAIN DAM

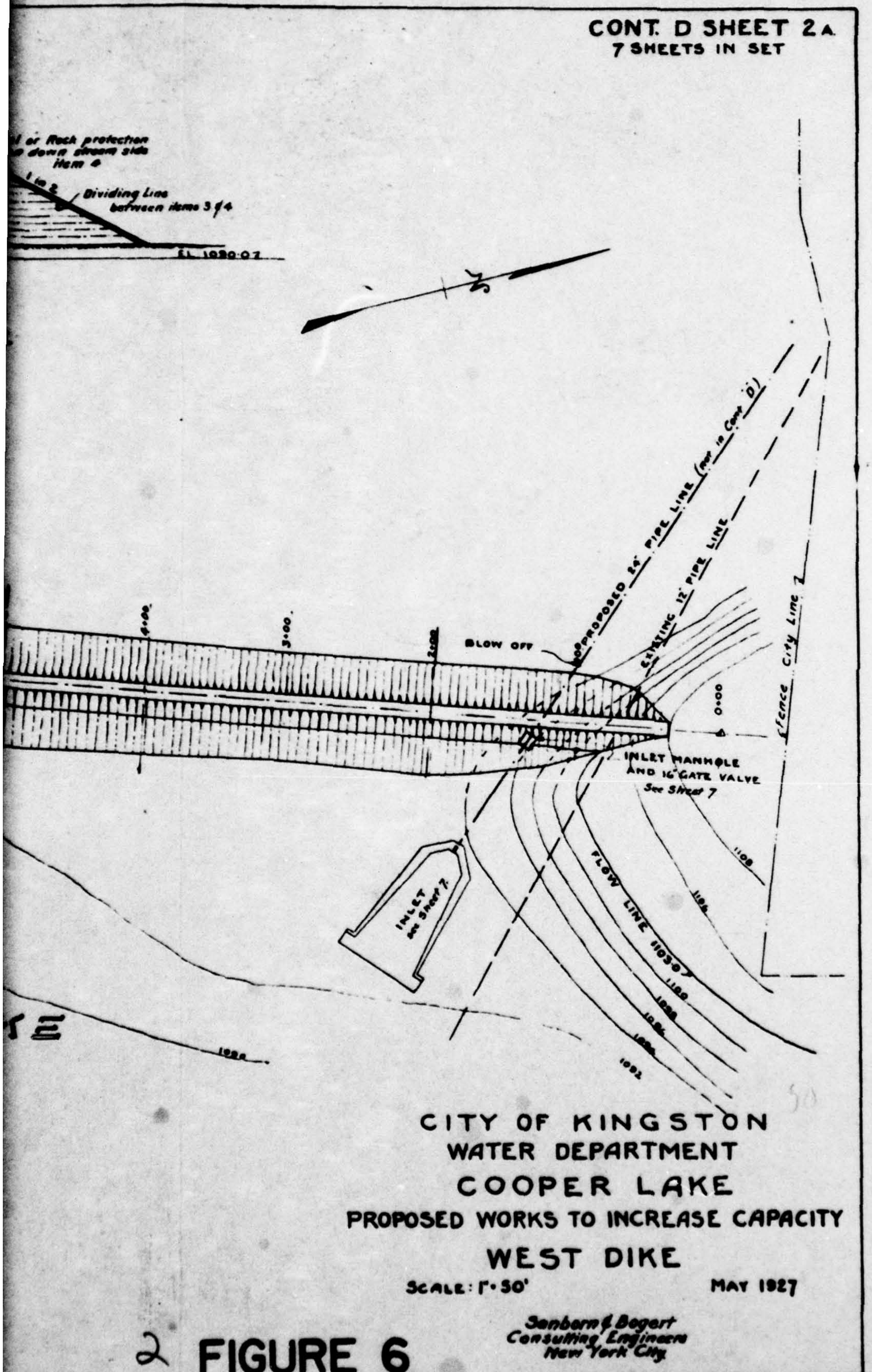
SCALE: 1"=10' FEBRUARY 1927

Sanborn & Bogert
Consulting Engineers
New York City

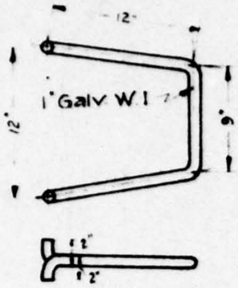
2 FIGURE 5



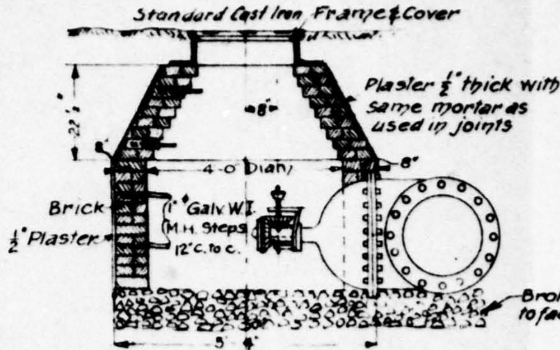
DETAIL OF PAVING
EL. 1108.0
FLOW LINE EL. 1102.0
Dividing line between items 3 & 5
Paving 14" thick item 5
ROLLED EARTH EMBANKMENT item 3
TYPICAL SECTION OF DIKE
SCALE: 1"=10'
EXISTING SMALL DIKE TO BE TRENCHED FOR DRAINAGE
Toe of Slope
FLOW LINE
Toe of Slope
ROAD
COOPER LA


CONT. D SHEET 2A.
7 SHEETS IN SET
Dividing Line between items 3 & 4
EL. 1090.07
PROPOSED 24" PIPE LINE
EXISTING 12" PIPE LINE
Fence City Line
BLOW OFF
INLET MANHOLE AND 16" GATE VALVE
See Sheet 7
INLET see Sheet 7.
FLOW LINE 1103.07
CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
WEST DIKE
SCALE: 1"=50'
MAY 1927
Sanborn & Bogert
Consulting Engineers
New York City

2 FIGURE 6

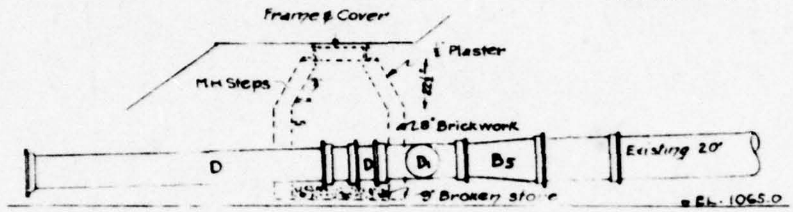


MANHOLE STEP
SCALE 1½"=1'-0"

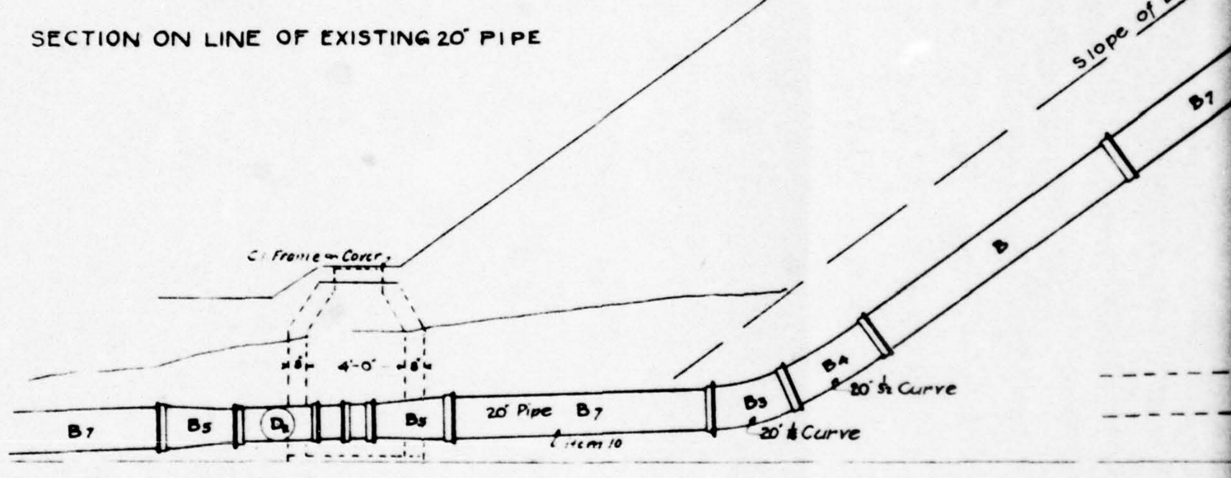


BRICK GATE CHAMBER item 12
SCALE: 1"=2'

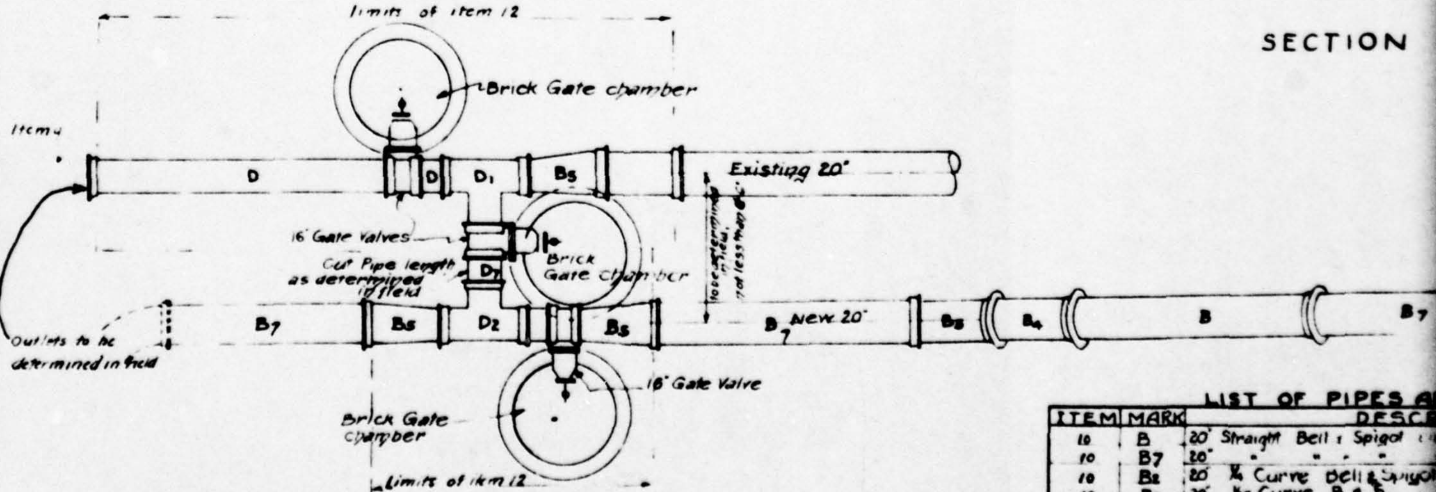
RAIL FENCE item 14
SCALE: 1"=4'



SECTION ON LINE OF EXISTING 20" PIPE



SECTION



PLAN OF CROSS-OVER

LIST OF PIPES A

ITEM	MARK	DESC
10	B	20" Straight Bell & Spigot
10	B7	20" " " "
10	B2	20 ¼ Curve Bell & Spigot
10	B3	20" 1/16 Curve B & S.
10	B4	20" 1/32 Curve B & S.
12	B5	20"-16" Reducer Bell & Sp
10	B6	20" Wall Sleeve 3'-6" lo
12	D	16" Straight C.I. Bell & Sp
12	D1	16" T. 2 Bells, spigot on
12	D2	16" T. 3 Bells
12		16" Gate Valves, double Be
12		Manhole Cover C.I.
12	D7	16" Straight Bell & Spigot

1

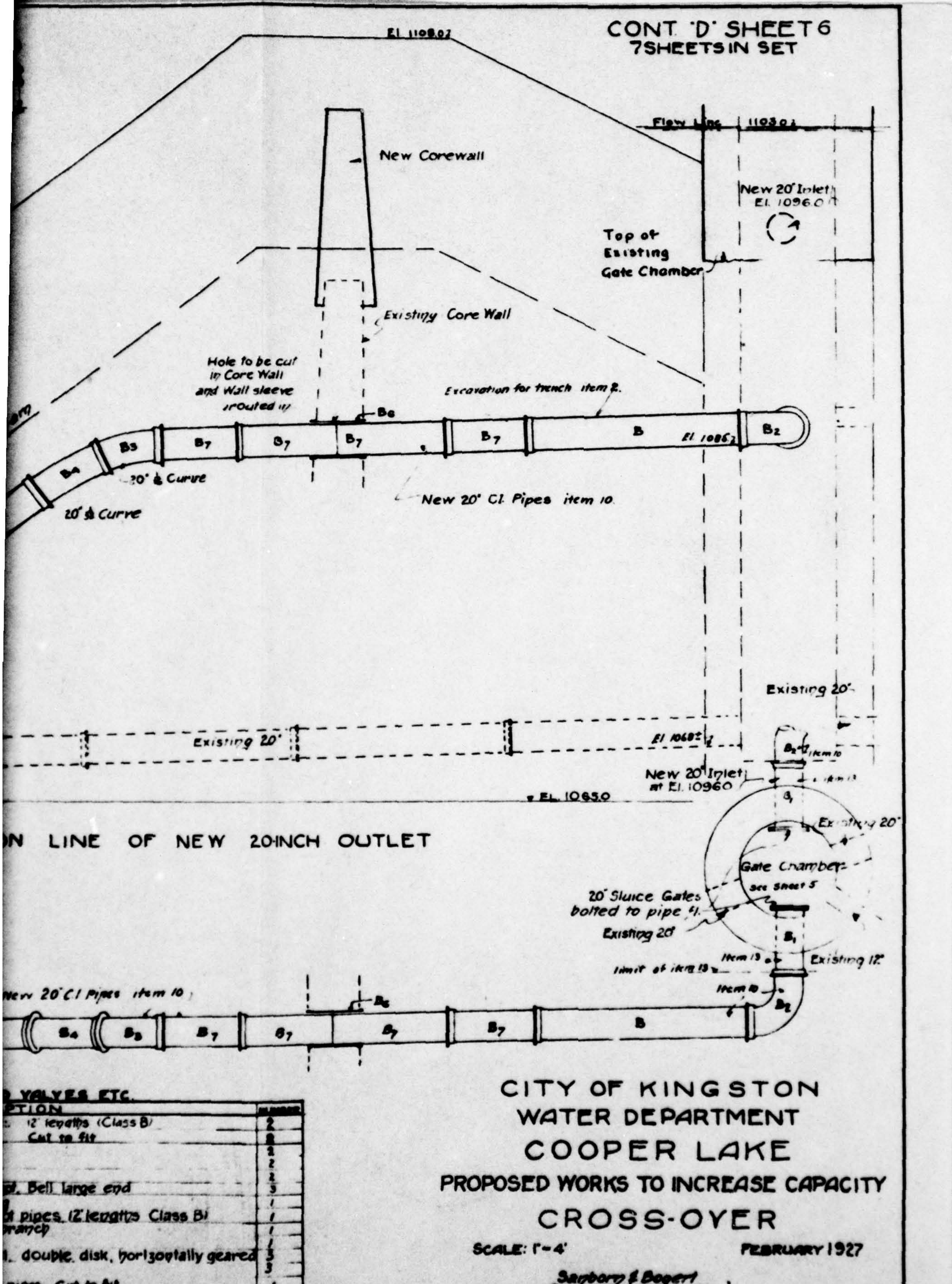

CONT. 'D' SHEET 6
7 SHEETS IN SET
El 1108.0±
Flow Line 1103.0±
New Corewall
New 20" Inlet
El. 1096.0
Top of Existing Gate Chamber
Existing Core Wall
Hole to be cut in Core Wall and Wall sleeve grouted in
Excavation for trench item 2.
B6
B3
B4
B7
B7
B7
B7
B
B2
El 1086.2
20° ℄ Curve
20° ℄ Curve
New 20" C.I. Pipes item 10.
Existing 20"
Existing 20"
El 1068±
New 20" Inlet at El. 1096.0
EL. 1065.0
ON LINE OF NEW 20-INCH OUTLET
Existing 20"
Gate Chamber
see Sheet 5
20" Sluice Gates bolted to pipe #1.
Existing 20"
Item 13
Limit of item 13
Item 10
Existing 12"
New 20" C.I. Pipes item 10
B6
B4
B3
B7
B7
B7
B7
B
B2
B1
B1
VALVES ETC.
PTION
12' lengths (Class B)
Cut to fit
Bell large end
pipes, 12' lengths Class B
branch
double disk, horizontally geared
pipes Cut to fit
CITY OF KINGSTON
WATER DEPARTMENT
COOPER LAKE
PROPOSED WORKS TO INCREASE CAPACITY
CROSS-OVER
SCALE: 1"=4'
FEBRUARY 1927
Sanborn & Bogert
Consulting Engineers
New York City

FIGURE 7

APPENDIX

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Cooper Lake Dam County Ulster State New York Coordinators ______

Date(s) Inspection June 26, 1978 Weather Fair Temperature 80°

Pool Elevation at Time of Inspection 1103.83 M.S.L. Tailwater at Time of Inspection 1065 M.S.L.

Inspection Personnel:

George C. Elias, P.E. James G. Ryan
Charles A. Richardson, P.E.
Frank E. Falcone, P.E.

Frank E. Falcone, P.E. Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	None.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	None.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No erosion observed.	None.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	No unusual vertical or horizontal alinement observed.	None.
RIPRAP FAILURES	None observed.	None.

EMBANKMENT

ISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
UNCTION OF EMBANKMENT ND ABUTMENT, SPILLWAY ND DAM	No cracking or misalinement observed.	None.
NY NOTICEABLE SEEPAGE	Seepage is occurring at one location at the toe of the dam. The water is clear and was tested for its composition. According to the operator, the reported composition of this water is not similar to reservoir water. It has been concluded that this water is from a spring characteristic of this region.	Flow should be monitored frequently to make sure that it remains clear, exhibits the same characteristics and does not increase.
STAFF GAGE AND RECORDER	None observed.	None.
DRAINS	Sections of pipes observed during visual inspection appeared to be in good condition.	None.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed (underwater section was not observed).	None.
INTAKE STRUCTURE	Appears to be well-maintained and in good condition.	None.
OUTLET STRUCTURE	Below ground level.	None.
OUTLET CHANNEL	Below ground level.	None.
EMERGENCY GATE	None observed.	None.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The top of the concrete weir is at elevation 1103. The spillway was raised to an elevation of 1103.83 by adding a 10" high timber stoplog. Considerable seepage passes between the stoplog and top of concrete weir. The concrete is in good condition with minor cracking being observed.	Condition of the concrete should be frequently monitored as well as the condition of the timber stoplog.
APPROACH CHANNEL	Clear and well-maintained, minor cracking in the concrete lining the channel. This concrete is not structural, but rather used to prevent bank erosion.	Cracks should be filled in.
DISCHARGE CHANNEL	Clear and well-maintained, minor debris present as well as minor concrete cracking in the apron.	Cracks should be filled in and debris removed.
BRIDGE AND PIERS	None.	None.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Heavily wooded, stable and clear of debris.	None.
SEDIMENTATION	Sediment present approximately 3' below the water surface elevation at spillway approach channel.	None.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Good condition, tree trunks and other debris present, as well as a small foot bridge. These could cause obstructions in high flows.	Remove all tree trunks and other debris.
SLOPES	Well-defined and stable.	None.
APPROXIMATE NO. OF HOMES AND POPULATION	40 to 50 homes and approximately 200 residents within one mile downstream of the reservoir. The community of Bearsville (Population approximately 500) 3 miles downstream.	None.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	* Blueprint provided in good condition, dated February, 1927.
REGIONAL VICINITY MAP	U. S. Geological Survey Quadrangle Sheet "Bearsville, New York".
CONSTRUCTION HISTORY	Original dam constructed in or about the year 1800. Extensive repairs took place in 1899-1900 and approximately 1924 to 1927.
TYPICAL SECTIONS OF DAM	* Same.
HYDROLOGIC/HYDRAULIC DATA	No hydrologic or hydraulic data was made available.
OUTLETS - PLAN - DETAILS -CONSTRAINTS -DISCHARGE RATINGS	Blueprint provided, dated February, 1927.
RAINFALL/RESERVOIR RECORDS	None made available.

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	Blueprints provided, dated February, 1927, in good condition.
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Blueprints provided, dated February, 1927, in good condition.

ITEM	REMARKS
MONITORING SYSTEMS	None made available. Operator on call 24 hours a day, resides at the dam site.
MODIFICATIONS	Various modifications, reconstruction and additions from 1899 to 1927.
HIGH POOL RECORDS	None made available.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Letter dated April 14, 1927, from Sanborn & Bogert Consulting Engineers, New York, to the Department of Public Works, Albany, New York, commenting on the application and plans for increasing the capacity of Cooper Lake.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported or no reports made available.
MAINTENANCE OPERATION RECORDS	None made available.

Check List
Visual Inspection
Phase 1

Name Dam Cooper Lake West Dike County Ulster State New York Coordinators ______

Date(s) Inspection June 26, 1978 Weather Fair Temperature 80°

Pool Elevation at Time of Inspection 1103.83 M.S.L. Tailwater at Time of Inspection 1065 M.S.L.

Inspection Personnel:

George C. Elias, P.E. James G. Ryan

Charles A. Richardson, P.E.

Frank E. Falcone, P.E.

Frank E. Falcone, P.E. Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed - Downstream face heavily wooded and covered with brush. Upstream face covered with aquatic plants.	The West Dike should be inspected for surface cracks after the banks are cleared of heavy brush.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Standing water is present along most of the toe of the dike - cracking or unusual movement could not be observed.	Beaver dams should be breached to allow for proper drainage of the area downstream of the toe.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.	None.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Minor variations in the elevation of the top of the dike.	Operator should check for swells or depressions occasionally.
RIPRAP FAILURES	None observed.	None.

EMBANKMENT

ISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No spillway.	None.
ANY NOTICEABLE SEEPAGE	Standing water and marshy areas are present downstream of the dike. Small springs are common to the area, but seepage should not be ruled out.	Implement a program to identify the source of the wet areas, place piezometer throughout the embankment to monitor pore pressures.
STAFF GAGE AND RECORDER	None.	None.
DRAINS	None.	None.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Heavily wooded, stable, clear of debris.	None.
SEDIMENTATION	Sedimentation not observed.	None.
INLET FROM MINK HOLLOW	Inlet concrete headwall badly deteriorated and broken in two sections.	Repair concrete headwall.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	* Buleprints provided in good condition, dated February, 1927.
REGIONAL VICINITY MAP	U. S. Geological Survey Quadrangle Sheet, Bearsville, New York.
CONSTRUCTION HISTORY	Dike constructed as part of major revisions which took place approximately 1927 for the purpose of raising the normal pool elevation from 1092.3 to 1103.
TYPICAL SECTIONS OF DAM	* Same.
HYDROLOGIC/HYDRAULIC DATA	None made available.
OUTLETS - PLAN - DETAILS -CONSTRAINTS -DISCHARGE RATINGS	Blueprints for inlet from Mink Hollow provided in good condition, dated February, 1927.
RAINFALL/RESERVOIR RECORDS	None made available.

PHOTOGRAPHS

CHANNEL DOWNSTREAM OF SPILLWAY

SPILLWAY

VIEW UPSTREAM AND DOWNSTREAM OF SPILLWAY

CLOSE-UP VIEW OF SPILLWAY

VIEW OF WEST DIKE

POND IMMEDIATELY DOWNSTREAM OF WEST DIKE

DOWNSTREAM FACE OF WEST DIKE

VIEW OF WEST DIKE

CHANNEL DOWNSTREAM OF SPILLWAY

VIEW OF TOP OF DAM

HYDROLOGIC AND HYDRAULIC CALCULATIONS

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 1 OF

DATE 7/25/78

NAME OF CLIENT

COMP. BY FEF

PROJECT Cooper Lake Dam

CHECKED BY DBC

DISCHARGE DETERMINATION

1. OVER SPILLWAY - $Q = CLH^{3/2}$

$C = 3.3$
$L = 36'$
SPILLWAY CREST EL. = 1103' + 10" TIMBER STOP LOG.

= 1103.83'

ELEVATION	HEAD	HEAD $^{3/2}$	DISCHARGE
1103.83	0	0	0
1104	0.17	0.07	8
1104.5	0.67	0.55	65
1105	1.17	1.27	151
1105.5	1.67	2.16	257
1106	2.17	3.20	380
1106.5	2.67	4.36	518
1107	3.17	5.64	670
1107.5	3.67	7.03	835
1108	4.17	8.52	1012

SHEET NO. 2 OF

DATE 7/11/78

NAME OF CLIENT

COMP. BY FEF

PROJECT COOPER LAKE DAM

CHECKED BY DBC

DETERMINATION OF DISCHARGE THROUGH 2 20" CAST IRON PIPES.

$$P_1/\gamma + V_1^2/2g + Z_1 - h_m = P_2/\gamma + V_2^2/2g + Z_2$$

$$0 + 0 + Z_1 - h_m = 0 + V_2^2/2g + 0$$

$$h_f + h_m = Z_1 - V_2^2/2g$$

$$f(L/D)\,V^2/2g + 2.5\,V^2/2g = Z_1 - V^2/2g$$

$$f(L/D)\,V^2/2g + 3.5\,V^2/2g = Z_1$$

$$V^2/2g\,[f(L/D) + 3.5] = Z_1$$

$$\frac{V_2^2}{2g} = \frac{Z_1}{[f(L/D) + 3.5]} \; ; \quad V_2^2 = \frac{64.4\,Z_1}{f(L/D) + 3.5}$$

$$V_2^2 = Q^2/A^2 \; ; \quad Q_2^2 = \frac{64.4\,A^2\,Z_1}{f(L/D) + 3.5}$$

FOR PIPE #1, $L/D = 59.88$, $A = 2.182\ FT^2$, $A^2 = 4.76$, AVE. $f = .038$

$$Q_2^2 = 53\,Z_1$$

ELEVATION	Z_1	Q^2	Q
1103.83	38.83	2058	45
1104	39	2067	45
1104.5	39.5	2094	46
1105	40	2120	46
1105.5	40.5	2147	46
1106	41	2173	47
1106.5	41.5	2200	47
1107	42	2226	47
1107.5	42.5	2253	47
1108	43	2279	48

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 3 OF

DATE 7/11/78

NAME OF CLIENT

COMP. BY FEF

PROJECT Cooper Lake Dam

CHECKED BY DBC

For Pipe #2, $L/D = 56.29$ $f = .038$

$Q_2^2 = 54.35\ Z_1$

ELEVATION	Z_1	Q^2	Q
1103.83	38.83	2110	46
1104	39	2120	46
1104.5	39.5	2147	46
1105	40	2174	47
1105.5	40.5	2201	47
1106	41	2228	47
1106.5	41.5	2256	47
1107	42	2283	48
1107.5	42.5	2310	48
1108	43	2337	48

Total Discharge Determination

ELEVATION	Q, SPILLWAY & DAM (cfs)	Q. PIPE #1 (cfs)	Q. PIPE #2 (cfs)	Q TOTAL (cfs)
1103.83	0	45	46	91
1104	8	45	46	99
1104.5	65	46	46	157
1105	151	46	47	244
1105.5	257	46	47	350
1106	380	47	47	474
1106.5	518	47	47	612
1107	670	47	48	765
1107.5	835	47	48	930
1108	1012	48	48	1108

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 4 OF ______

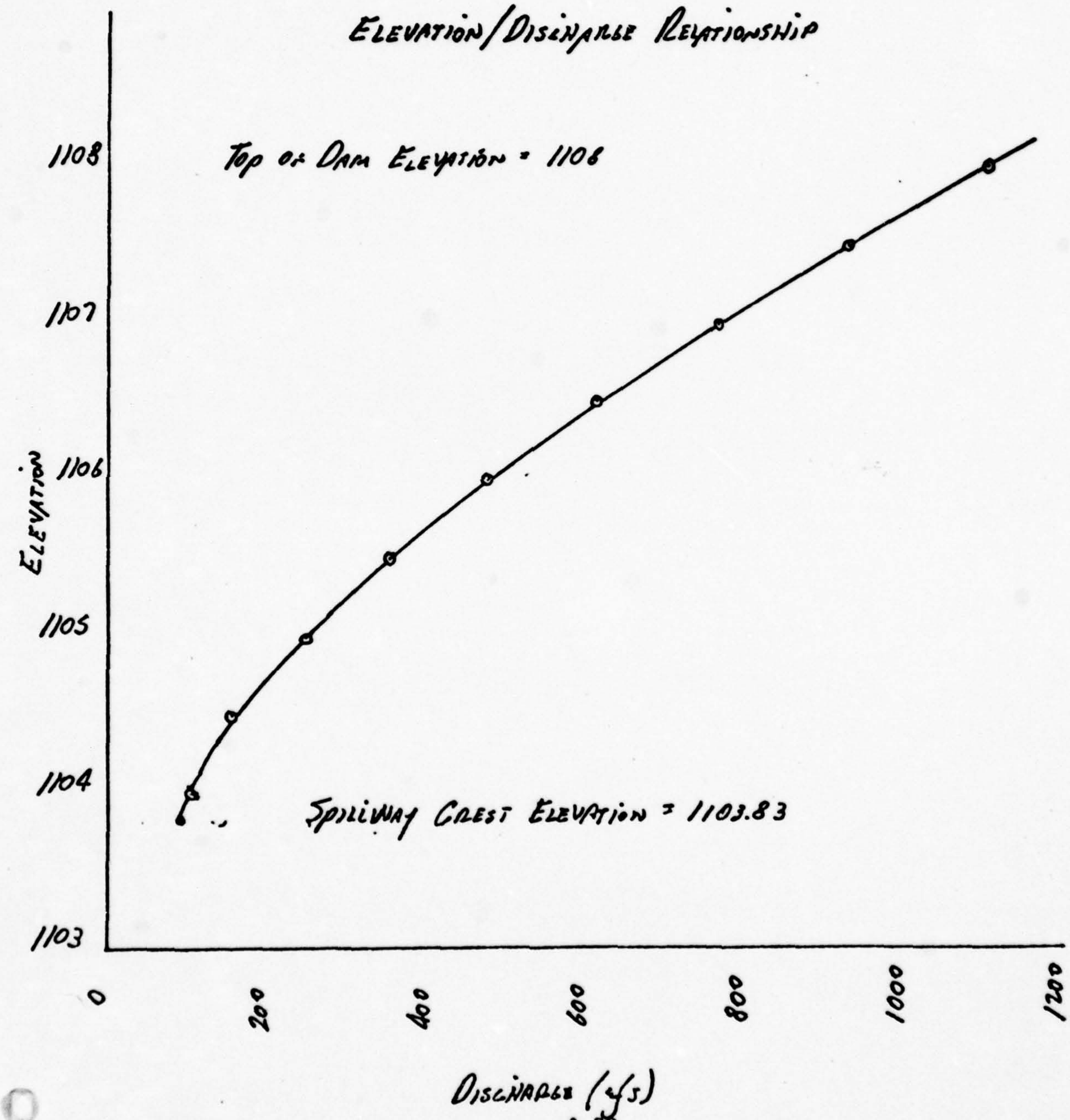
DATE 7/25/78

NAME OF CLIENT ______

COMP. BY F.F

PROJECT Cooper Lake Dam

CHECKED BY DBC



JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 5 OF

DATE 7/25/78

NAME OF CLIENT

COMP. BY FEF

PROJECT Cooper Lake Dam

CHECKED BY DBC

STORAGE DETERMINATION

@ SPILLWAY CREST, STORAGE = 3683 Ac. Ft. (EL = 1103.83)

AREA = 120 ACRES

@ TOP OF DAM, STORAGE = 4201 Ac. Ft. (EL. = 1108)

AREA = 128 ACRES

RISE: 8 ACRES/4.17 = 1.92 ≅ 2 ACRES/FT.

AREA = 2D + 120

STORAGE = $D^2 + 120\,D$ D = 4.17', STORAGE = 17.39 + 500.4 = 517.79 ≅ 518

STORAGE ABOVE SPILLWAY CREST

ELEVATION	DEPTH	D^2	120 D	STORAGE
1103.83	0	0	0	0
1104	0.17	.03	20.4	20.4
1104.5	0.67	.45	80.4	80.9
1105	1.17	1.37	140.4	141.8
1105.5	1.67	2.79	200.4	203.2
1106	2.17	4.71	260.4	265.1
1106.5	2.67	7.13	320.4	327.5
1107	3.17	10.05	380.4	390.5
1107.5	3.67	13.47	440.4	453.9
1108	4.17	17.39	500.4	517.8

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 6 OF

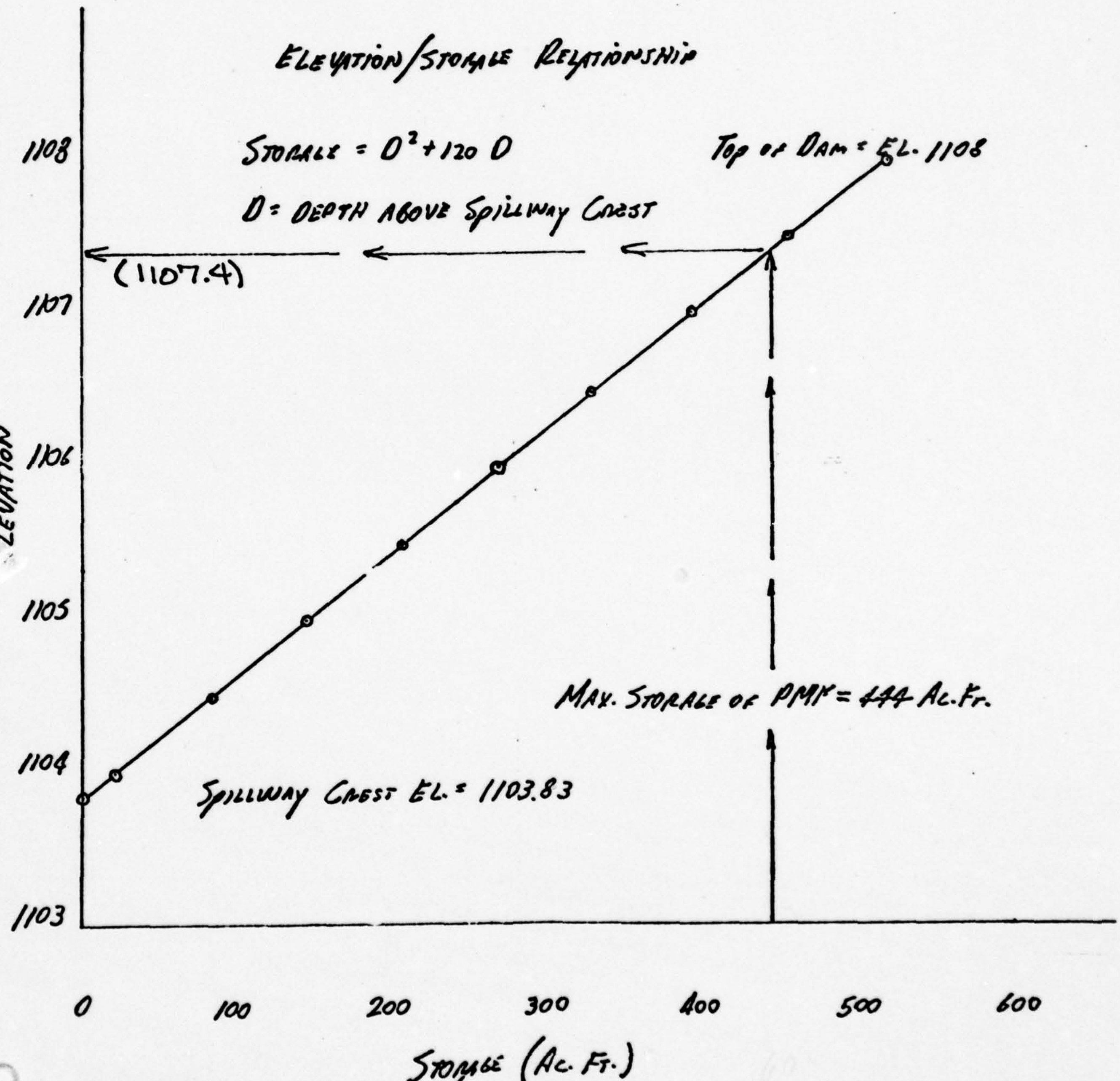
DATE 7/26/78

NAME OF CLIENT

COMP. BY FBF

PROJECT Cooper Lake Dam

CHECKED BY DBC



SHEET NO.____ OF ____
DATE 8/23/78
NAME OF CLIENT NYSDEC
COMP. BY DBC
PROJECT Cooper Lake
CHECKED BY ZEH

6 hr. 10-sq. mi PMP = 23"

Storm Misfit reduction = 20%

Net PMP = 18.4"

Distribution of Rainfall

Time	% of 6 HR PMP	PMP Σ	PMP Incr	Third quartile
1	49	9.0	9.0	1.4
2	65	12.0	3.0	1.7
3	75	13.8	1.8	1.8
4	84	15.5	1.7	9.0
5	92	17.0	1.5	3.0
6	100	18.4	1.4	1.5

Time of Concentration

1. SCS Curve Number Method

$l = 3700'$ $\quad Y = 15\%_{\text{AVE.}}$ $\quad S = \frac{1000}{CN} - 10 \; (CN = 55)$

$$Lag = \frac{l^{.8} \times (S+1)^{.7}}{1900 \times Y^{.5}} = .46 \text{ hrs.} \approx 28 \text{ min}$$

2. SCS Overland Flow Method

Average Overland flow velocity

$V_o \approx 1.25$ ft/sec [forested (some ground cover; & 15% slope]

$L_o = 3700'$ $\quad T_t = 3700 \text{ ft} / 1.25 \text{ ft/sec} = 2960 \text{ sec}$

$T_c = T_t = 2960 \text{ sec} \approx \underline{\underline{49.5 \text{ min}}}$ ⇐ use

Let $D = 12$ min

$T_p = 12/2 + .6 \times 50 \approx 36$ min

$T_b = 2.67 \times T_p = 96$ min.

$$q_p = \frac{DA \times 5280^2/12}{(T_b/2) \times 60} \approx 549 \text{ cfs/in}$$

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 8 OF

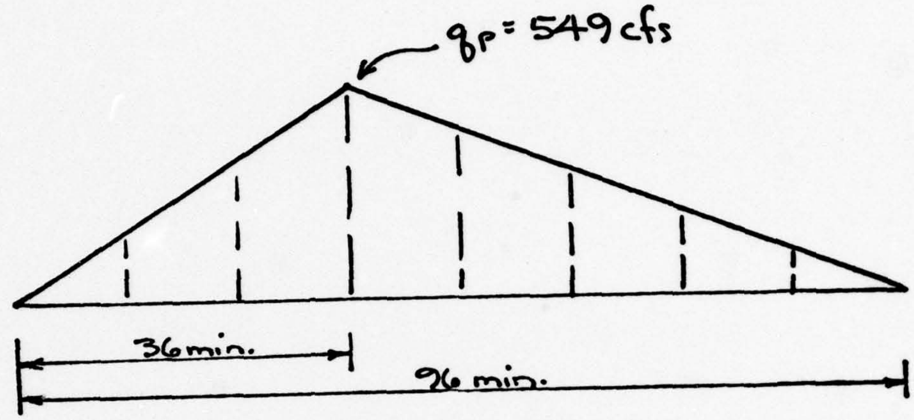
DATE 8/8/78

COMP. BY DBC

CHECKED BY FEF

NAME OF CLIENT NYSDEC

PROJECT Cooper Lake



t (min)	q (cfs)
0	0
12	183
24	366
36	549
48	439
60	329
72	220
84	110
96	0

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO._____OF_____

DATE 8/23/78

NAME OF CLIENT NYSDEC

COMP. BY DBC

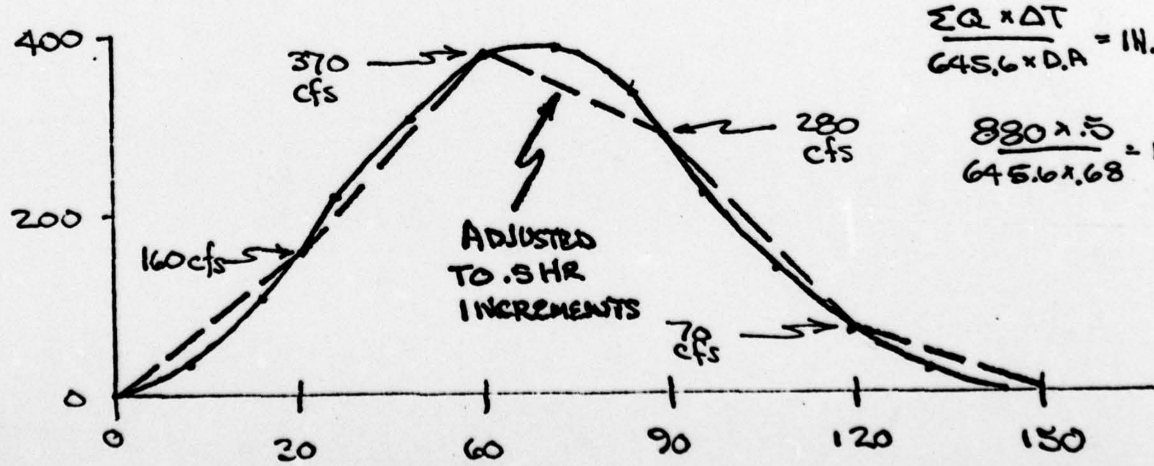
PROJECT Cooper Lake

CHECKED BY REH

Develop 1hr. unit graph from 12 min. unit graph (using calculator program)

1 hour unit graph

Time (min)	q (cfs)
0	0
12	37
24	110
36	220
48	307
60	373
72	381
84	329
96	220
108	132
120	66
132	22
144	0



$$\frac{\Sigma Q \times \Delta T}{645.6 \times D.A} = 1N.R$$

$$\frac{880 \times .5}{645.6 \times .68} = 1.$$

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 9 OF

DATE 7/26/78

NAME OF CLIENT

COMP. BY FEF

PROJECT Cooper Lake Dam

CHECKED BY DBC

DRAWDOWN COMPUTATIONS

DRAWDOWN IS ACCOMPLISHED THROUGH 2 20" PIPE. TAILWATER ELEVATION BOTH IS 1065. INLET ELEVATION FOR PIPE #1 IS 1085. INLET ELEVATION FOR PIPE #2 IS 1068.

(FROM COMPUTATION SHEET # 2 & 3)

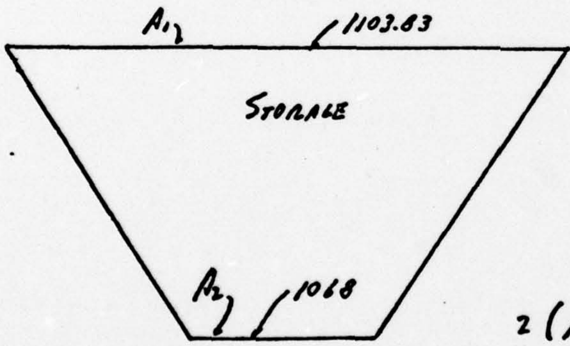
PIPE #1 $\quad Q^2 = 53 Z_1$

PIPE #2 $\quad Q^2 = 54.35 Z_1$

} DISCHARGE EQUATIONS

(STORAGE) @ EL. 1103.83, STORAGE = 3683 ACRE FT., AREA = 120 ACRES

@ EL. 1068, STORAGE = 0 (ASSUME).



$$\text{STORAGE} = \left(\frac{A_1 + A_2}{2}\right) \times D$$

$$3683 = \left(\frac{120 + A_2}{2}\right) \times 35.83$$

$$2(102.79) = 120 + A_2$$

$$205.58 - 120 = A_2$$

$$A_2 = 85.58 \text{ ACRES}$$

RISE = (120 − 85.58)/35.83 = .96 ACRES/FT. (BELOW 1103.83).

AREA = .96 D + 85.58

STORAGE = .48 D^2 + 85.58 D

JUSTIN & COURTNEY, INC.
Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET NO. 10 OF ____

DATE 7/28/78

NAME OF CLIENT ____

COMP. BY FEF

PROJECT Cooper Lake Dam

CHECKED BY DBC

$$\text{Storage} = .48D^2 + 85.58\,D.$$

ELEVATION	DEPTH	$.48D^2$	$85.58\,D$	STORAGE	INCREMENT STORAGE
1068	0	0	0	0	
1070					350.0
1072	4	7.7	342.3	350.0	
1074					365.3
1076	8	30.7	684.6	715.3	
1078					380.8
1080	12	69.1	1027.0	1096.1	
1082					396.1
1084	16	122.9	1369.3	1492.2	
1085					203.7
1086	18	155.5	1540.4	1695.9	
1088					419.2
1090	22	232.3	1882.8	2115.1	
1092					434.5
1094	26	324.5	2225.1	2549.6	
1096					449.8
1098	30	432.0	2567.4	2999.4	
1101					683.1
1103.83	35.83	616.2	3066.3	3682.5	

ELEVATION	DISCHARGE PIPE #1 (cfs)	DISCHARGE PIPE #2 (cfs)	TOTAL * DISCHARGE (cfs)	INCREMENT STORAGE (Ac. Ft.)	TIME HRS.	TIME DAYS
1101	29.1	44.2	71.9	683.1	115	4.8
1096	24.2	41.0	63.8	449.8	85.3	3.6
1092	19.3	38.3	56.2	434.5	93.5	3.9
1088	0	35.4	34.0	419.2	149.2	6.2
1085	0	33.0	31.6	203.7	78.0	3.2
1082	0	30.4	29.0	396.1	165.3	6.9
1078	0	26.6	25.2	380.8	182.8	7.6
1074	0	22.1	20.7	365.3	213.5	8.9
1070	0	16.5	15.1	350.0	280.5	11.7

* Accounts for inflow of 2 cfs / sq. mi. drainage area

$2 \times .68 = 1.36$ cfs.

Total Drawdown Time = 56.8 Days.

Drawdown time = 57 Days

```
*****************************
HEC-1 VERSION DATED JAN 1973
UPDATED AUG 74
CHANGE NO. 01
*****************************
                              COOPER LAKE DAM
                               PMF HYDROLOGY
                      NATIONAL DAM INSPECTION PROGRAM

                             JOB SPECIFICATION
            NO   NHR  NMIN  IDAY   IHR  IMIN METRC  IPLT  IPRT NSTAN
            50     0    30     1     0     0     0     0     0     0
                             JOPER    NWT
                                 5      0

                     MULTI-PLAN ANALYSES TO BE PERFORMED
                        NPLAN= 1 NRTIO= 5 LRTIO= 1
          RTIOS=    .20     .40     .60     .80    1.00

  **********   **********   **********   **********   **********

                        SUB-AREA RUNOFF COMPUTATION
             ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME
                 1       0       0       0       0       0       0

                              HYDROGRAPH DATA
     IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
         0      -1     .68    0.00    0.00    0.00   0.000       0       0       0

                               PRECIP DATA
                          NP   STORM     DAJ     DAK
                          11    0.00    0.00    0.00
                               PRECIP PATTERN
   1.40     0.00     1.70     0.00     1.80     0.00     9.00     0.00     3.00     0.00
   1.50

                                 LOSS DATA
     STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
      0.00    0.00    1.00    0.00    0.00    1.00    0.00     .10    0.00    0.00

                        GIVEN UNIT GRAPH, NUHGQ=   6
      0.     160.     370.     280.      70.       0.
            UNIT GRAPH TOTALS    880. CFS OR 1.00 INCHES OVER THE AREA

                               RECESSION DATA
              STRTQ=    0.00    QRCSN=    0.00    RTIOR= 1.00

                            END-OF-PERIOD FLOW
                         TIME    RAIN    EXCS     COMP Q
                      1  0 30    1.40    1.35         0.
                      1  0 60    0.00    0.00       216.
                      1  1 30    1.70    1.65       500.
                      1  1 60    0.00    0.00       642.
                      1  2 30    1.80    1.75       705.
```

1	5	30	1.50	1.45	1718.
1	5	60	0.00	0.00	1058.
1	6	30	0.00	0.00	743.
1	6	60	0.00	0.00	406.
1	7	30	0.00	0.00	102.
1	7	60	0.00	0.00	0.
1	8	30	0.00	0.00	0.
1	8	60	0.00	0.00	0.
1	9	30	0.00	0.00	0.
1	9	60	0.00	0.00	0.
1	10	30	0.00	0.00	0.
1	10	60	0.00	0.00	0.
1	11	30	0.00	0.00	0.
1	11	60	0.00	0.00	0.
1	12	30	0.00	0.00	0.
1	12	60	0.00	0.00	0.
1	13	30	0.00	0.00	0.
1	13	60	0.00	0.00	0.
1	14	30	0.00	0.00	0.
1	14	60	0.00	0.00	0.
1	15	30	0.00	0.00	0.
1	15	60	0.00	0.00	0.
1	16	30	0.00	0.00	0.
1	16	60	0.00	0.00	0.
1	17	30	0.00	0.00	0.
1	17	60	0.00	0.00	0.
1	18	30	0.00	0.00	0.
1	18	60	0.00	0.00	0.
1	19	30	0.00	0.00	0.
1	19	60	0.00	0.00	0.
1	20	30	0.00	0.00	0.
1	20	60	0.00	0.00	0.
1	21	30	0.00	0.00	0.
1	21	60	0.00	0.00	0.
1	22	30	0.00	0.00	0.
1	22	60	0.00	0.00	0.
1	23	30	0.00	0.00	0.
1	23	60	0.00	0.00	0.
2	0	30	0.00	0.00	0.
2	0	60	0.00	0.00	0.
		SUM	18.40	18.10	15927.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3434.	1301.	332.	313.	15928.
INCHES		17.80	18.16	18.16	18.16
AC-FT		645.	659.	659.	659.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

0.	43.	100.	128.	141.	148.	153.	384.	687.	596.
344.	212.	149.	81.	20.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	687.	260.	66.	66.	3186.
INCHES		3.56	3.63	3.63	3.63
AC-FT		129.	132.	132.	132.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

```
                      PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
              CFS    1374.      520.      133.      127.          6371.
           INCHES                7.12      7.26      7.26           7.26
            AC-FT                258.      263.      263.           263.

                   HYDROGRAPH AT STA     1 FOR PLAN 1, RTIO 3
       0.      130.      300.      385.      423.      445.      458.     1153.     2060.     1787.
    1031.      635.      446.      244.       61.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                      PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
              CFS    2060.      781.      199.      191.          9557.
           INCHES               10.68     10.89     10.89          10.89
            AC-FT                387.      395.      395.           395.

                   HYDROGRAPH AT STA     1 FOR PLAN 1, RTIO 4
       0.      173.      400.      514.      564.      594.      610.     1538.     2747.     2382.
    1374.      846.      594.      325.       81.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                      PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
              CFS    2747.     1041.      265.      255.         12742.
           INCHES               14.24     14.53     14.53          14.53
            AC-FT                516.      527.      527.           527.

                   HYDROGRAPH AT STA     1 FOR PLAN 1, RTIO 5
       0.      216.      499.      642.      705.      742.      763.     1922.     3434.     2978.
    1718.     1058.      743.      406.      102.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                      PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
              CFS    3434.     1301.      332.      319.         15928.
           INCHES               17.80     18.16     18.16          18.16
            AC-FT                645.      659.      659.           659.


 **********          **********          **********          **********          **********

                                   HYDROGRAPH ROUTING
                    ISTAQ     ICOMP     IECON     ITAPE      JPLT      JPRT     INAME
                        2         1         0         0         0         0         0
                                      ROUTING DATA
                              QLOSS     CLOSS       AVG      IRES     ISAME
                                0.0     0.000      0.00         1         1

                    NSTPS     NSTDL       LAG     AMSKK         X       TSK     STORA
                        0         0         0     0.000     0.000     0.000       -1.

STORAGE=        0.       20.       81.      142.      203.      265.      328.      391.      454.      518.
OUTFLOW=        0.       99.      157.      244.      350.      474.      612.      765.      930.     1108.

                               STATION       2, PLAN 1, RTIO 1
       0.        4.       17.       35.       53.       70.       85.      103.      120.      140.
                                    157.      151.      147.      141.      136.      131.      126.
```

STOR

0.	1.	3.	7.	11.	14.	17.	24.	42.	63.
76.	81.	82.	81.	76.	71.	65.	59.	53.	48.
43.	38.	33.	29.	24.	20.	17.	13.	11.	9.
7.	6.	5.	4.	3.	3.	2.	2.	1.	1.
1.	1.	1.	1.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	159.	143.	66.	64.	3182.
INCHES		1.96	3.63	3.63	3.63
AC-FT		71.	132.	132.	132.

STATION 2, PLAN 1, RTIO 2

0.	8.	33.	69.	101.	108.	115.	132.	173.	236.
284.	302.	306.	301.	287.	269.	250.	235.	221.	209.
197.	185.	175.	165.	156.	150.	144.	139.	133.	128.
123.	118.	114.	109.	105.	101.	91.	74.	60.	49.
40.	33.	26.	22.	18.	14.	12.	9.	8.	6.

STOR

0.	2.	7.	14.	22.	29.	37.	54.	92.	137.
165.	176.	178.	175.	167.	156.	146.	136.	126.	117.
109.	101.	93.	86.	80.	74.	67.	62.	56.	51.
45.	40.	36.	31.	27.	22.	18.	15.	12.	10.
8.	7.	5.	4.	4.	3.	2.	2.	2.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	306.	258.	132.	127.	6344.
INCHES		3.53	7.22	7.23	7.23
AC-FT		128.	262.	262.	262.

STATION 2, PLAN 1, RTIO 3

0.	12.	50.	100.	112.	124.	137.	165.	249.	367.
450.	480.	486.	473.	448.	415.	382.	352.	327.	304.
283.	264.	245.	231.	218.	205.	194.	183.	172.	162.
154.	148.	143.	137.	132.	127.	122.	117.	113.	108.
104.	100.	86.	70.	57.	46.	38.	31.	25.	20.

STOR

0.	2.	10.	21.	33.	46.	60.	87.	145.	211.
253.	268.	270.	265.	252.	235.	219.	204.	190.	177.
165.	153.	143.	133.	124.	115.	107.	99.	92.	85.
78.	72.	66.	60.	55.	49.	44.	39.	34.	30.
25.	21.	17.	14.	12.	9.	8.	6.	5.	4.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	486.	397.	197.	183.	9467.
INCHES		5.43	10.78	10.79	10.79
AC-FT		197.	391.	391.	391.

STATION 2, PLAN 1, RTIO 4

0.	16.	66.	107.	124.	141.	160.	212.	340.	518.
633.	684.	687.	666.	621.	570.	521.	476.	438.	403.
371.	343.	319.	297.	276.	257.	240.	226.	213.	201.
190.	179.	169.	159.	152.	146.	141.	135.	130.	125.
120.	116.	111.	107.	103.	98.	80.	65.	53.	43.

STOR

0.	3.	13.	29.	46.	65.	83.	120.	197.	285.
339.	358.	359.	350.	332.	309.	286.	266.	247.	230.
214.	199.	185.	172.	161.	150.	139.	130.	121.	112.

INCHES		7.52	14.29	14.31	14.31
AC-FT		273.	518.	519.	519.

STATION 7, PLAN 1, RTIO 5

0.	20.	83.	114.	136.	159.	193.	262.	441.	685.
849.	905.	904.	870.	807.	732.	662.	600.	548.	501.
459.	422.	389.	358.	332.	309.	288.	268.	249.	234.
221.	208.	196.	185.	174.	164.	156.	150.	144.	138.
133.	128.	123.	118.	114.	109.	105.	101.	90.	73.

STOR

0.	4.	17.	36.	59.	83.	106.	153.	249.	358.
423.	444.	444.	431.	407.	377.	349.	322.	299.	277.
257.	239.	222.	207.	193.	179.	167.	156.	145.	135.
126.	117.	108.	101.	93.	86.	79.	73.	67.	61.
56.	50.	45.	40.	35.	31.	26.	22.	18.	15.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	905.	710.	325.	312.	15607.
INCHES		9.71	17.77	17.79	17.79
AC-FT		352.	644.	645.	645.

********** ********** ********** ********** **********

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS				
OPERATION	STATION	PLAN	.20	.40	.60	.80	1.00
HYDROGRAPH AT	1	1	687.	1374.	2060.	2747.	3434.
		2	0.	0.	0.	0.	0.
ROUTED TO	2	1	159.	306.	486.	687.	905.
		2	0.	0.	0.	0.	0.

ADDITIONAL REPORTS

JAMES F. SAN[illegible]
CLINTON L. B[illegible]

SANBORN AND BOGERT
CONSULTING ENGINEERS
30 CHURCH STREET
NEW YORK

April 14, 1927.

Mr. Thomas L. Watkins
Acting State Engineer
Department of Public Works
Albany, N. Y.

Dear Sir:

Referring to the application and plans for dams for increasing the capacity of Cooper Lake for Kingston, N. Y., and your letter of March [illegible], 1927, we wish to make the following comments regarding the design.

There are two dams, (1) the existing dam with spillway 28' high, and (2) the new west dike.

(1) Existing Dam. This structure consists of a masonry section about 15' long and 33' high, with earth embankment provided with core walls at either side of the masonry spillway section, (Sheet 2a). It is proposed to raise the water of the Lake a little less than 11'. The proposed design of this dam contemplates raising the core wall which is to be carried across the existing masonry spillway section and placing earth embankment on the existing slopes and parallel with them. The earth slopes are thoroughly well stabilized. The down-stream slope stands at present somewhat steeper than 1 on 1½. Soundings on the water side show the slope to be about 1 on 1½. The material of the existing embankment of this dam is well compacted and impervious. Our design contemplates a slope on the back of the dam of 1 on 1½, covered with rock spoil, thus the dam already forms a well compacted core in the earth portion, and in the spillway portion a very broad masonry section with an apron on the down-stream side 3' thick of impervious concrete extending to the outer toe of the slope a distance of about 27' beyond the masonry dam, which is about 21' [illegible] at the base. Our design contemplates covering all of this masonry at the highest section with embankment on each water side and down-stream side;

the [illegible] would have a width at the base somewhat over [illegible] according to our design, for a depth of water of about [illegible]'.

In view of the excellent character of the material and the fact that the existing dam and earth slopes are already well stabilized, with a heavy masonry section and broad down-stream apron at the deepest portion, we feel that an entirely safe and ample section has been provided.

In view of the conditions, we feel that our design is well considered, and because of the local circumstances, we respectfully request your approval of the designs as submitted for raising the existing dam.

(2) West Dike. This is a rolled earth embankment, with a maximum of just under 12' of water at the deepest portion; for a considerable part of the length there will be less than 10 or 11' of water against the dike.

We were somewhat uncertain whether it was necessary under the law to file these plans as we understand that anything under 12' does not require approval by the State Engineer.

Our design provides for rock spoil on the back of the dam which will serve to stabilize the slope, and a heavy paving on the water side which will serve the same function. In view of the very low head of water in this case and in view of the stabilizing effect of the slopes due to the rock and pavement, we feel that the slopes provided are adequate since the bottom width of the embankment as designed is 83 feet, with 11' of water; using the slopes recommended in your letter, namely 1 on 2½ and 1 on 2, with a 10' top, a 2' freeboard works out a 68' bottom width, - this is presumably without the stabilizing effect of the rock fill. In other words our design gives all you ask.

With regard to your recommendation that a core wall be used in this section; this subject was discussed with your Engineer on Mr. Sanborn's visit to Albany; in view of the slight depth of water we understood that the core wall could be omitted, particularly since the material for this embankment is ideal, consisting of [illegible] just enough clay material so that the embankment packs perfectly and makes a thoroughly impervious dam.

The design for the embankment of the Birnewater Reservoir for Kingston, now under construction, as approved by the State Engineer, has a depth of water of 20', slopes of 1 on 2 and 1 on 1½, and no core in the rolled earth portion of the embankment, which is material similar to that at Cooper Lake, (print enclosed).

In view of these circumstances, particularly considering the low head of water against the embankment and considering the ample width of the base and the impervious character of the material, we respectfully request approval of the design as submitted.

Yours very truly,

Jno. F. Sanborn.

SANBORN AND BOGERT

JFS.X